FOOD PREFERENCES OF MULE DEER ON THEIR SUMMER RANGE

1975-76 FY

FINAL REPORT
In fulfillment of PSW Grant No. 19

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ABSTRACT

Tractable deer, 11 fawns and 5 yearlings, were used to study food preferences of California mule deer (Odocoileus hemionus) on their summer range within the North Kings Watershed, Sierra National Forest, California, from June through October 1975. A total of 97 feeding trials on 4 sites produced 12,498 minutes of observations and 43,165 "bites." A total of 140 food items, of which 135 were vascular plants, were eaten by the deer. Species important in the diet from the meadow complex were: Rumex angiocarpus, Potentilla glandulosa, and Polygonum bistortoides. Diets from the wooded areas were dominated by: Ceanothus cordulatus, Chrysolepis sempervirens, and Prunus emarginata. The total diet of fawns and yearlings were not significantly different from the same sites. The diets of fawns in 1975 did not differ significantly from the diets of fawns from 1974 for the same phenological period at the same site.

Chemical analyses on 270 forage samples were completed. All crude protein levels for the eight preferred species met minimum maintenance levels needed by deer with most crude protein levels at optimal levels. All calcium levels exceeded minimum levels needed by deer and were often at optimum levels. However, phosphorous levels were slightly below those minimum levels recommended by some workers for deer maintenance but met levels suggested in other studies. Calcium:phosphorous ratios generally were within normally accepted levels of nutritional balance. In general, seasonal changes in the nutrient content of these forages followed predicted patterns previously reported in the literature. No obvious

nutritional deficiencies were apparent in these eight important forage species sampled from the summer range of the North Kings Deer Herd.

Range vegetation included 40 samples for a total of 20,000 m of line intercept. Sixty-five vascular plants were measured including 8 tree species, 19 shrub species, and 38 forbs. Point-quarter was used to measure trees for stratification. Nine tree species were encountered. Vegetation sampling indicates the range studied does not differ from communities as described by Munz (1959).

INTRODUCTION

The decreasing population of mule deer (Odocoileus hemionus) in the North Kings Deer Herd Range, estimated to have declined from some 15,000 animals in 1954 to about 3,500 animals in 1972, has produced demands for management action to reverse this population trend. However, insufficient information exists on the actual diet of mule deer in this region. This project determined the dietary preferences of mule deer on their summer range of the North Kings Deer Herd Range. Qualitative and quantitative analysis of vegetation on the summer range was done in conjunction with determination of the forage preferences of the deer.

Previous studies of the diet of mule deer here have not been extended in detail to the summer months of June, July, August, and September. These months may be critical in determining the survival of deer along the fall migration routes, particularly of the fawn age class, but no data existed outlining the dietary preferences of deer in the North Kings area during the summer months.

Changes within and between seasonal nutritional levels of different parts of vascular plants important in the diets of cattle and deer may be the key to determining the population expansion or decline of these species. Little work with reasonable statistical precision has been done to date on establishing the nutritional changes that key vascular plants undergo within the North Kings watershed. These data are needed before an understanding of the effects of nutrition on animal populations in this area can be obtained. For this project three objectives were established:

(1) To determine qualitatively the food preferences of mule deer on the summer range in the Dinkey subunit of the North Kings Deer herd;

(2) To qualitatively and quantitatively describe the vegetation available for use to mule deer on summer range within the Dinkey Creek subunit; and

(3) To determine the chemical and mineral composition of selected vascular plants throughout their growing season and if possible, relate chemical and mineral content to seasonal, physiological, and physiographical conditions.

Once diet preferences are determined and the nutritive contributions of each plant group to the deer herd evaluated, the hypothesis of nutritional shortages can either be confirmed or denied. This information then lays the foundation for habitat improvement programs if shortages of essential plants are confirmed. Fieldwork for this study was conducted from 1 June through 28 October 1975.

METHODS AND MATERIALS

Fawn Raising and Training Procedures

California mule deer fawns were supplied to us by the California Department of Fish and Game during the summer of 1975. These fawns were raised and trained according to the procedures described by Evans et al. (1975) and Reichert (1972). These fawns, and the deer trained during the summer of 1974 were used to determine food preferences.

Growth of the fawns was documented during the first 3 months of life (Updike 1976). Hindfoot length, contour length, girth, height at the shoulder, ear length, and tail length were measured on a periodic basis (Anderson et al. 1974). Linear measurements were recorded to the nearest cm. Fawns were weighed periodically in a burlap bag or on a platform scale and their weights recorded to the nearest 10 gm.

Selection of Study Sites

Selection of sample sites was based on observations from 1974 and 1975. Use of a site by wild deer was the major criterion for selecting an area as a study site. This use was monitored by spotlight observations and by observing

tracks, pellet groups, and forage use at the sites. Accessibility to vehicles was a minor consideration in site selection. Neff (1974), Watts (1964), and Healy (1967) also felt accessibility was a necessary consideration in selecting a study site.

Determination of Food Preferences

The tractable deer were transported to the study site in pairs or trios in an enclosed pickup truck and allowed to roam at will within the study site. Morning feeding trials began between 0600 and 0800; evening feeding trials began between 1600 and 1800. All feeding trials lasted until the deer ceased feeding. We attempted to work all animals an equal number of times. Between trials, the animals were kept in a pen near the study sites and maintained on a high protein pelleted ration, alfalfa hay, and water. We did not restrict the ration of our deer because Wallmo et al. (1972) found that their tractable deer grazed most avidly when fed an unrestricted ration.

Bite data, phenological information, and weather conditions were recorded with battery operated, hand held, cassette tape recorders. At the beginning of each feeding trial, the observer recorded the data, weather conditions, and starting time. At the end of the trial, time and weather conditions were noted. Plant phenology on the site was recorded each time feeding trials were conducted.

A bite, the unit of measurement used to quantify food preferences, was defined as each discrete removal of part of a plant or, in some cases, removal of the entire plant from the gound (Wallmo et al. 1972).

Percent of diet was calculated for each food item by dividing the number of bites for each sampling period by the total number of bites

recorded. Diet composition was calculated for each sampling period, males, females, morning trials, and evening trials. Spearman's rho, a non-parametric correlation coefficient, was used to test for correlation between diets of the two sexes and morning and evening feeding trials (Sokal and Rohlf 1969, Conover 1971). Differences were tested at the .05 significance level. Data summarization and tabulation was done on a preliminary basis in the field and completed by computer programs at the Center for Information Processing, California State University, Fresno.

Preference Index

To relate the diets of the tractable deer to forage availability, and to describe the study sites, the line intercept method was used to measure shrub cover on the study sites (Canfield 1941). As the tractable deer seldom ate vegetation extending more than 1.4 m above the ground, we included only the portions of plants below this height in our analysis.

Previous work in the summer of 1974 indicated that browse species were by far the most important species in tractable deer diets on the summer range, so no analysis for herbaceous plants was attempted (Evans et al. 1975).

We used a numerical selectivity index to describe deer food preferences. The selectivity index = percent of a species in the diet / percent relative cover of that species. Other workers have used similar measures of preference (Watts 1964, Neff 1974). A selectivity index greater than 1.0 indicates that a species is preferred and eaten in greater proportion than its relative cover. A selectivity index less than 1.0 indicates that a species was eaten in proportion less than its relative cover and was not a preferred species.

Analysis of Range Vegetation

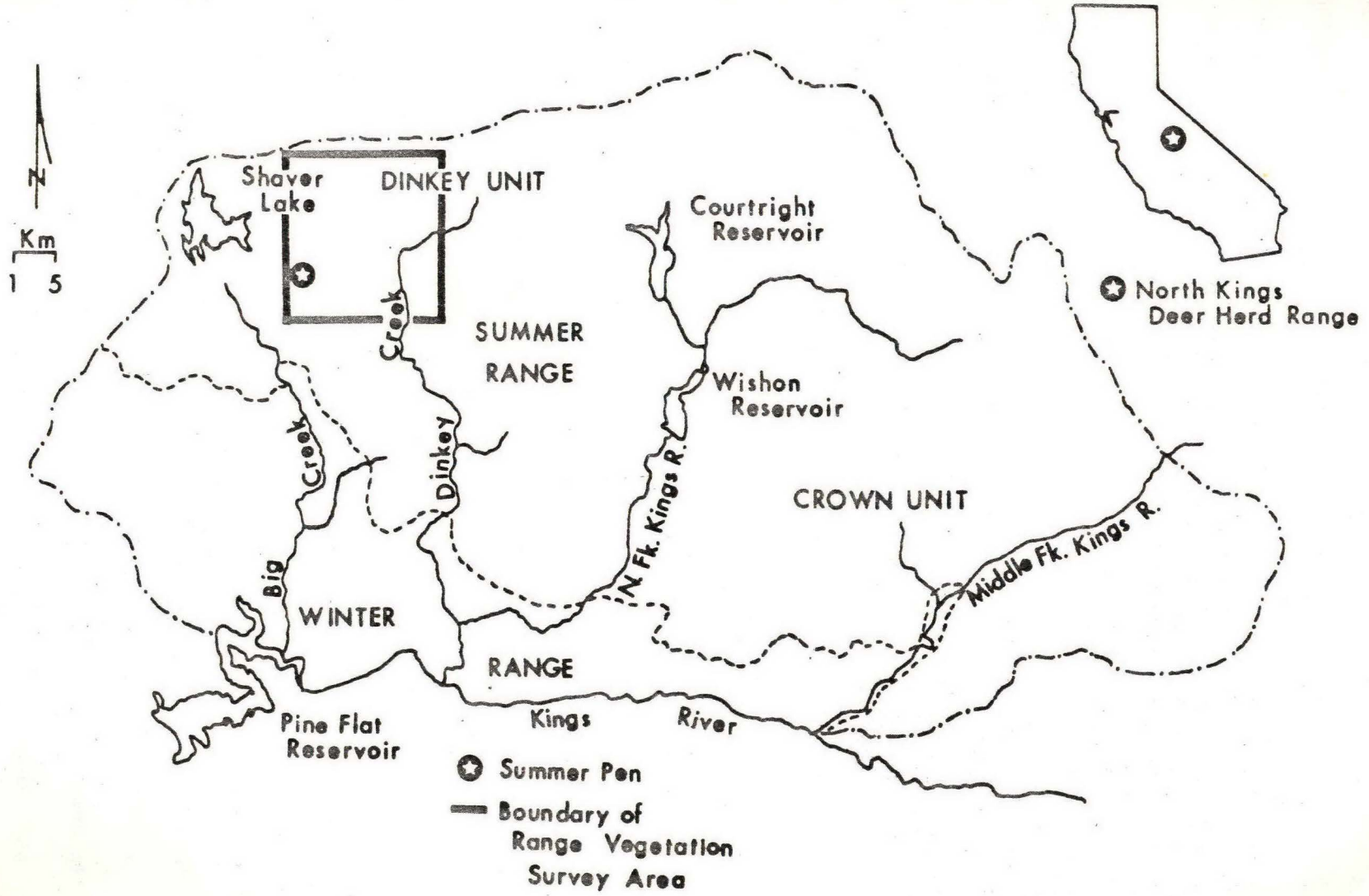
A portion of the Dinkey sub-unit of the North Kings deer herd was selected as a study area to determine forage availability for deer (Fig. 1). This area was diverse, ranging in elevation from about 1,340 m to about 2,610 m and, including such plant communities as the yellow pine forest, red fir forest, and lodgepole pine forest (Munz 1959).

Forty 500 m transects were randomly located within the study area. Section lines were used to grid off the study area. Points on the grid were selected from a table of random numbers and a random azimuth selected for the bearing of the line from that point. Shrub cover along the length of the line was measured by the line intercept method (Canfield 1941). Ten points were randomly located along each of these lines. At each of these points, trees were measured using the point quarter method (Mueller-Ellenberg and Dombois 1974) and herbaceous vegetation was measured by the inclined point frame method (Levy and Madden 1933). Distance to each tree and the diameter at breast height (DBH) of each tree were recorded to the nearest cm. Only trees 3 cm or larger were included in the point quarters (Daubenmire 1968). Exposure and slope of each line were recorded to the nearest degree with a compass and Abney hand level.

Nutritional Value of Forage

Eight species of plants important in the diets of the tractable deer during the summer of 1974 were analyzed for nutritional value between 24 July and 28 October 1975. These dates include the lactation period for does, the period during and immediately after weaning, and the period of maximum growth. These species were greenleaf manzanita (Arctostaphylos patula), bitter cherry (Prunus emarginata), Sierra gooseberry (Ribes

Fig. 1. Location of the range of the North Kings deer herd, Fresno County, California.


N
Km
1 5
Shaver Lake
DINKEY UNIT
Courtright Reservoir
North Kings Deer Herd Range
SUMMER RANGE
Creek
Wishon Reservoir
Big Creek
Dinkey
N. Fk. Kings R.
CROWN UNIT
Middle Fk. Kings R.
WINTER RANGE
Pine Flat Reservoir
Kings River
Summer Pen
Boundary of Range Vegetation Survey Area

Roezlii), snowberry (Symphoricarpos acutus), black oak (Quercus Kelloggii), mountain whitethorn (Ceanothus cordulatus), hazelnut (Corylus cornuta), and chinquapin (Chrysolepis sempervirens). Scientific names of plants follow those of Munz (1959, 1968). The crude protein, fat, ash, calcium, and phosphorus content of these species was measured by proximate analysis. Acid detergent fiber content was measured by the Van-Soest method (Van Soest 1967). We measured the percent of moisture on an oven-dry basis in the field.

Plants were collected in the field and returned to the lab trailer where the samples were stripped as quickly as possible to decrease moisture loss. We collected the same portions of the plants that were utilized by our tractable deer.

For each species, 5 samples of 5 gm wet weight each were dried at 80 C (Thomas 1927). Percentage moisture in the samples was then calculated from the dry weight remaining. The remainder of the plant material was also dried at 80 C for 24 h and then divided into 10 gm samples. Five 10 gm samples of each species in each sampling period were sent to Agricultural Testing and Consultants, Inc., Twin Falls, Idaho, for the chemical analyses. We sampled the vegetation for nutritional values at biweekly intervals. We also attempted to collect food preference data that corresponded to the plant sampling periods.

RESULTS AND DISCUSSION

Fawn Rearing

Eleven fawns were supplied to us by the California Department of Fish and Game during the summer of 1975. All 11 fawns were raised successfully and were alive at the time of this report. Last year, 3 of the 11 fawns we received died before weaning (Evans et al. 1975). Two of these fawns died

from enterotoxemia, a disease that can be caused from overeating. The third fawn had no recognizable diseases. As a whole, the fawns we received this year were in better health and physical condition than the fawns we received last year. However, we do not feel this materially contributed to the better success achieved this year.

In 1974, the fawns were fed various commercially available, non-pelleted grains. These grains contained molasses and readily dried out when placed in the feed pans. As a result, the deer may have overeaten at times when fresh grain was placed in the feed pans. In 1975, the fawns were fed a pelleted ration. We feel these pellets reduced any tendencies the fawns may have had to overeat by remaining fresh for a long period of time. Additionally, the fawns raised in 1975 were innoculated against enterotoxemia and leptospirosis as soon as practical after birth.

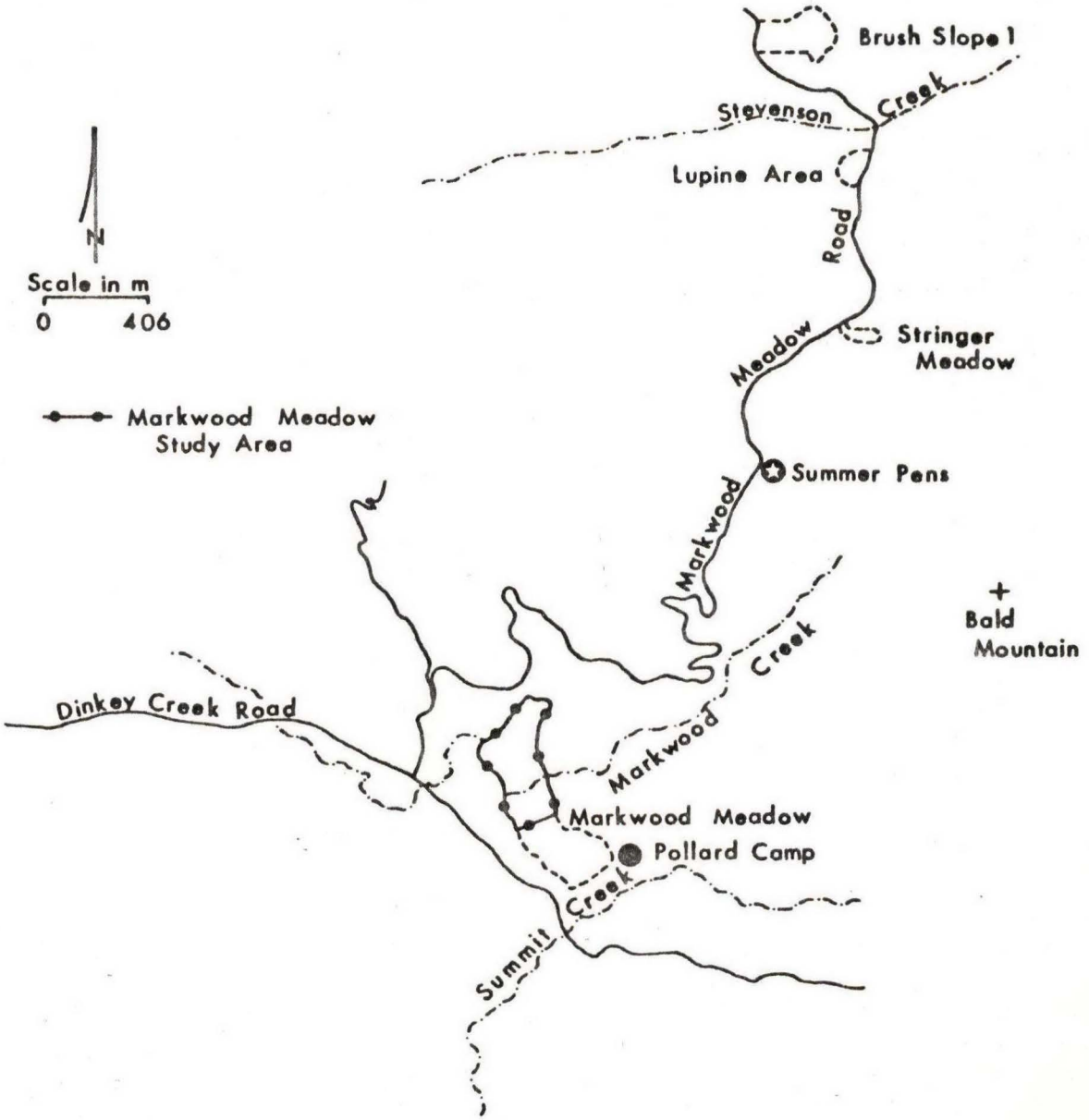
One fawn was received that weighed only about 1.9 kg at birth. This about one-half the normal weight at birth of a California mule deer fawn from the North Kings herd (Salwasser 1974, Holl 1976). She received extra care and medication from us and was reared with only minor problems. Another fawn was received that developed a possible allergy. He "outgrew" his symptoms and is a usable deer. Other than these two fawns, we experienced no major health problems in rearing the fawns. Subjectively, it seems to us that diarrhea problems were less severe in 1975 than in 1974.

Two male fawns were received that were flighty and hard to manage. One of these fawns is unusable in the field at the current time and the other deer is usable only at some times.

Food Preferences

Four study sites were sampled during the summer and early fall of 1975 (Fig. 2). Two of these areas, Brush Slope 1 and Lupine Area, were

Fig. 2. Location of the study sites used for sampling the food preferences of tractable deer on the summer range of the North Kings deer herd, Fresno County, California


Brush Slope 1
Stevenson Creek
Lupine Area
Road
Meadow
Stringer Meadow
N
Scale in m
0 406
Markwood Meadow Study Area
Summer Pens
Markwood
Bald Mountain
Creek
Dinkey Creek Road
Markwood
Markwood Meadow
Pollard Camp
Creek
Summit

brush slopes that were sampled during the summer of 1974. The other two sites were Stringer Meadow and Markwood Meadow. Markwood Meadow was a new site for 1975. Another brush slope was sampled during 1974 but was not studied during 1975.

Results of the Spearman's rho tests for dietary correlations between the times of day and the sexes indicated no significant differences for all comparisons (Table 1).

Markwood Meadow

Meadows are thought to be important in the summer diets of deer on the North Kings range (Salwasser 1974). Markwood Meadow was observed to be utilized by deer in previous years, and was selected to study the food preferences of deer in meadows.

Markwood Meadow is located on the Dinkey Creek road, 9.6 km from the junction of Highway 168, in section 3, T10S., R25E. MDM. at an elevation of about 1770 m. The portion of the meadow used for our sample site is fenced, and bounded by the Dinkey Creek road, the Markwood Meadow road, and Pollard Camp (Figs. 2 and 3). Clayton (1974) studied the vegetative composition of a portion of our study area.

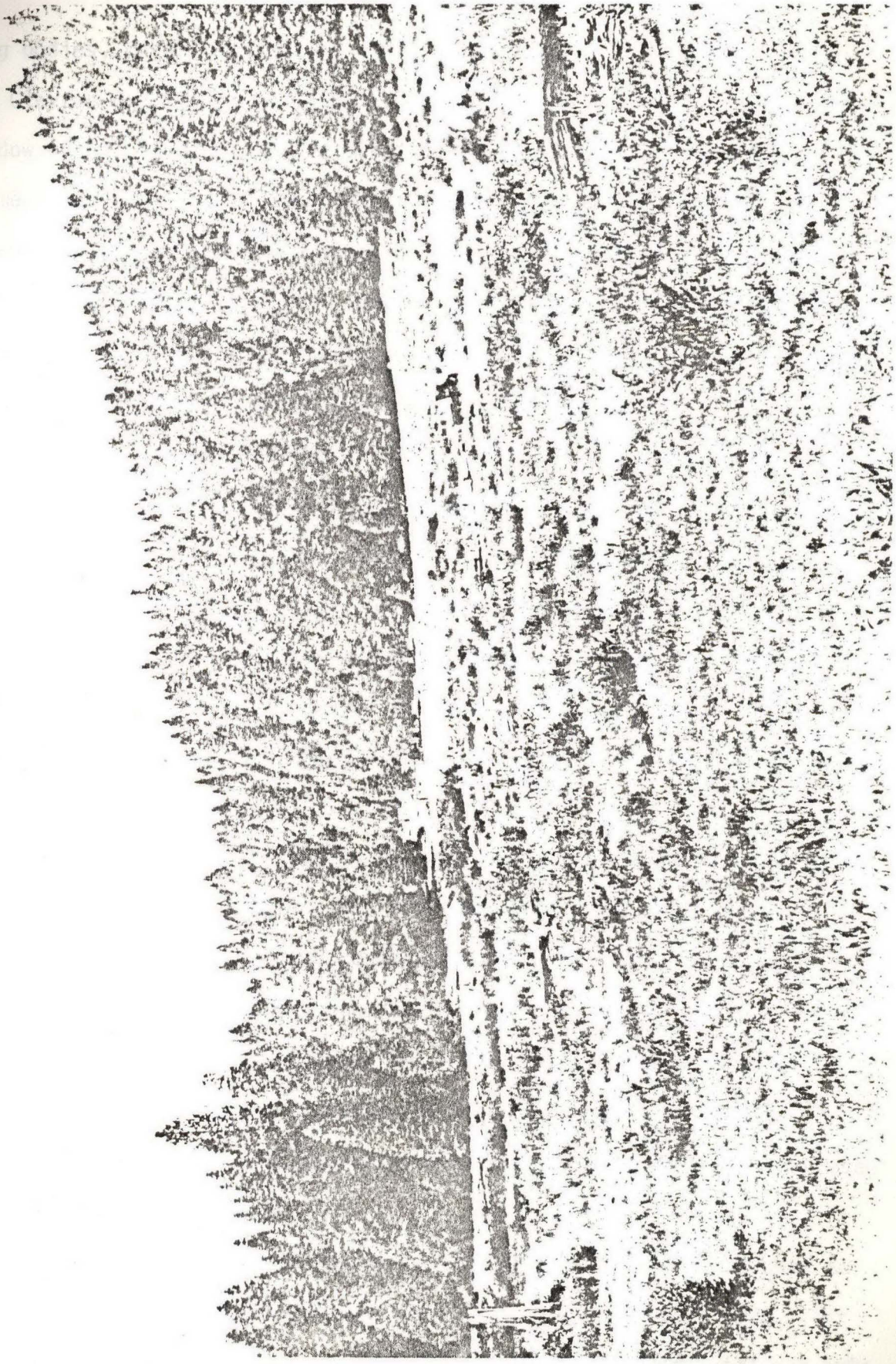
Clayton (1974) described the western portion of our study site as being composed of two strata: a wet central stratum dominated by Carex aquatilis, C. vernacula, and Deschampsia caespitosa; and a drier stratum dominated by Juncus oxymeris. Our observations indicate his idea of two strata is correct for this limited portion of the meadow. However, the species named by Clayton (1974) as dominants were not found during our observations. Carex aquatilis was not dominant in the wet stratum, but C. nebrascensis was the dominant sedge in that stratum. Without mature

TABLE 1

Correlation of the diets of the tractable deer on the summer range of the North Kings deer herd, Fresno County, California

Sample Site	Comparison	Calculated Spearman's Rho	Degrees of freedom	Significance level
Lupine Area	♂ X ♀ fawns	.458	20	$p < .05$
	am X pm fawns	.519	20	$p < .05$
Brush Slope #1	♂ X ♀ fawns	.821	14	$p < .05$
	am X pm fawns	.850	14	$p < .05$
	♂ X ♀ yearlings	.702	14	$p < .05$
	am X pm yearlings	.652	14	$p < .05$
Markwood Meadow	♂ X ♀ yearlings	.761	17	$p < .05$
	am X pm yearlings	.875	17	$p < .05$

Fig. 3. Representative vegetation of Markwood Meadow, Sierra National Forest, Fresno County. The photo faces almost due North and was taken in July 1975.



fruiting bodies, these two species could be difficult to separate (Munz 1959). Clayton described the Juncus vegetation type as being restricted to the meadow edges, however, we found this type in some relatively dry spots in the meadow center. He stated that a lupine (Lupinus longifolius) was a dominant species in the drier edges of the meadow, but was not sampled by his sampling procedures. This species of lupine is a coastal species (Munz 1959) and we did not locate it in our survey. Lupinus polyphyllus was identified as the dominant perennial lupine in the meadow.

Other areas besides the two strata mentioned by Clayton (1974) are present in our study area. The central area, characterized by Clayton (1974) as a "disturbed central area" surrounds Markwood Creek and is drier and sandier than the other portions of the meadow. No typical meadow species were found in this area, with the exception of aquatic grasses, sedges, and rushes found in the creek. Plants of disturbed or sandy areas such as Rumex angiocarpus, Gayophytum eriospermum, and Polygonum aviculare dominated the vegetation of this area.

Another area, not mentioned by Clayton, was located between the central area and Pollard Camp. This area was heterogeneous, and contained the strata named by Clayton, but also contained other indistinct strata.

Clayton (1974) did not mention the existence of shrub species, but the meadow does contain some shrubs. On the northeast side of the meadow, several large plants of Sierra gooseberry grew on dry spots. On the southeast side, two patches of blueberry (Vaccinium occidentale) were present in a wet portion of the meadow.

Five yearling deer, raised by us in the summer of 1974, were used to sample food habits in Markwood Meadow from 16 June to 18 August 1975. Our spotlighting and daytime observations indicated that wild deer utilized this

site during June and July, but that wild deer use had declined by the middle of August (Table 2). Feeding trials were halted when it became apparent that wild deer use decreased in Markwood Meadow. No fawns raised by us in the summer of 1975 were used in the Markwood phase of this study as most were not ready for use in the field until the feeding trials had been stopped.

A total of 12,320 bites were recorded in 3,798 minutes of observation on 20 feeding trials in Markwood Meadow. The tractable deer utilized a total of 80 food items, including 77 species of vascular plants.

Forbs dominated the diet of the tractable deer in Markwood Meadow and comprised about 75 percent of the total diet (Fig. 4). Grasses and sedges made up about 12 percent of the total diet. Browse species were limited in abundance, but still comprised 9.6 percent of the total diet (Table 3).

Forbs. Sheep sorrel (Rumex angiocarpus) was the most important species in the total diet (Table 3). It made up 25 to 29 percent of the diet at the beginning of summer and decreased to about 13 percent of the diet by the middle of August (Fig. 5). Dixon (1934), Linsdale and Tomich (1956), and Russell (1932) reported that deer ate another species of sheep sorrel, Rumex Acetosella. Rumex angiocarpus is difficult to separate from R. Acetosella and, in the past, was considered a subspecies of R. Acetosella (Munz 1959). We feel that some of the use of R. Acetosella reported by these earlier workers may have actually been R. angiocarpus. While the exact taxonomic status of this species may have questionable, there is little doubt that it is an important deer food in Markwood Meadow. Cinquefoil (Potentilla glandulosa), 13.6 percent, knotweed (Polygonum bistortoides), 11.2 percent, and Ivesia (Ivesia unguiculata), 8.9 percent, were other important forbs (Table 3). Knotweed has been reported by Kufeld et al. (1973) to be eaten by mule deer. Cinquefoil has been reported by Dixon (1934), Evans (1976), and Russell (1932)

TABLE 2

Number of wild deer observed in Markwood Meadow
Sierra National Forest

Date	Number	Date	Number
21 June	6	17 August	1
3 July	5	19 August	0
7 July	8	27 August	2
8 July	10	28 August	1
14 July	8	29 August	1
17 July	5	4 September	1
15 August	4	5 September	0

TABLE 3

Diets of the yearling deer on Markwood Meadow in the Sierra National Forest during summer 1975

Species	Bites	Percent Diet
Rumex angiocarpus	2845	23.09
Potentilla glandulosa	1681	13.64
Polygonum bistortoides	1375	11.16
Ivesia unguiculata	1094	8.88
Ribes Roezlii	1002	8.13
Juncus oxymeris	727	5.90
Gayophytum diffusum	612	4.97
Frageria vesca	567	4.60
Carex spp.	534	4.34
Potentilla gracilis	470	3.81
Lotus Purshianus	156	1.27
Epilobium spp.	139	1.13
Camassia Leitchlinii	120	0.97
Scirpus Congdonii	101	0.82
Vaccinium occidentalis	99	0.80
Ceanothus codulatus	97	0.79
Polygonum spp.	74	0.60
Gramineae	68	0.55
Dodecatheon Jeffreyi	49	0.40
Taraxicum officinale	47	0.38
Perideridia Gairdneri	39	0.32
Other items	424	3.43
Total	12,320	100.00

Fig. 4. Diet of the tractable deer in Markwood Meadow during summer 1975 as broken down into three major forage classes.

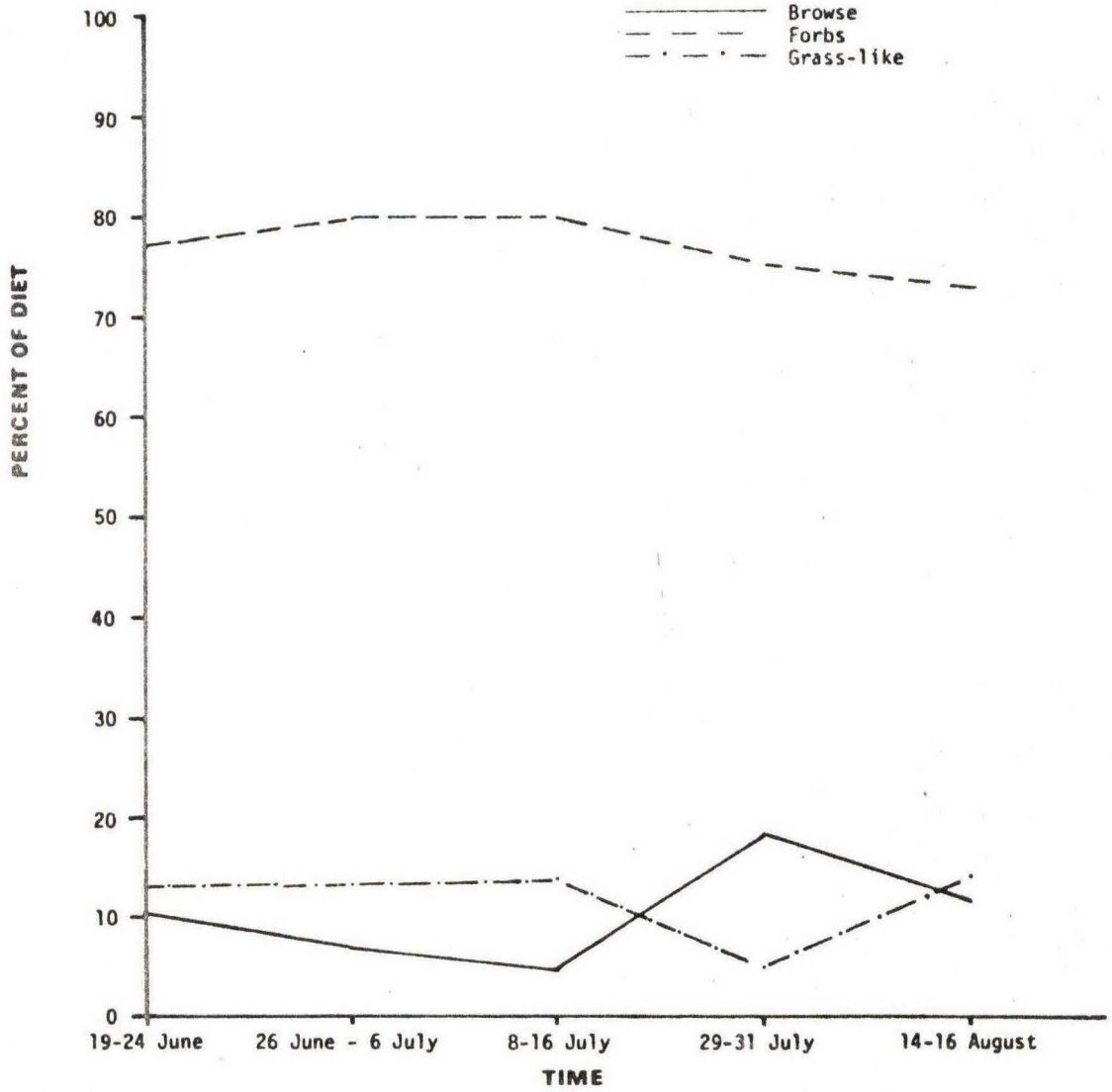
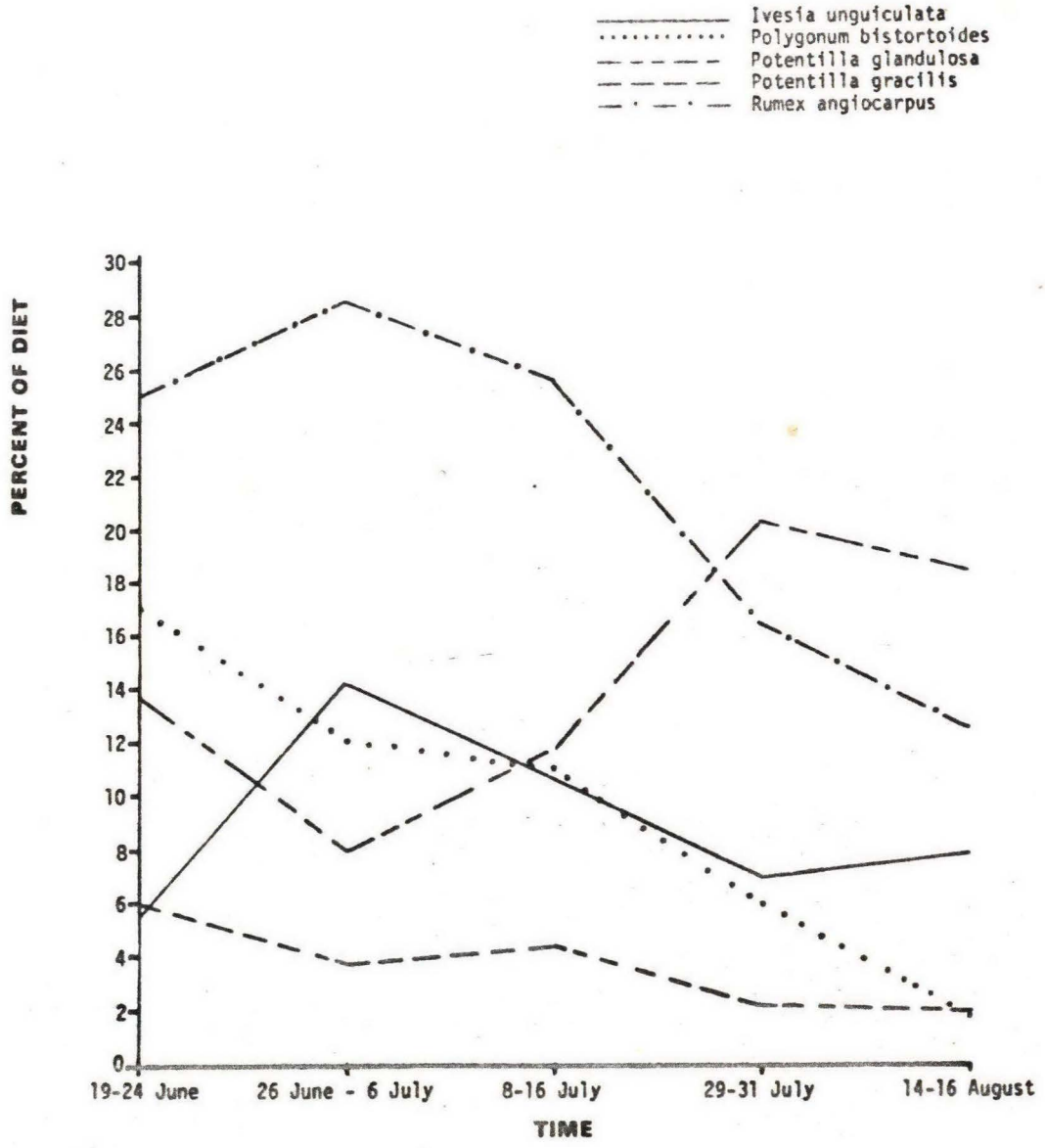

Browse
Forbs
Grass-like
100
90
80
70
60
50
40
30
20
10
0
PERCENT OF DIET
19-24 June
26 June - 6 July
8-16 July
29-31 July
14-16 August
TIME

Fig. 5. Important dominant species of forbs in the diets of the tractable deer in Markwood Meadow during summer 1975.


Ivesia unguiculata
Polygonum bistortoides
Potentilla glandulosa
Potentilla gracilis
Rumex angiocarpus
PERCENT OF DIET
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
19-24 June
26 June - 6 July
8-16 July
29-31 July
14-16 August
TIME

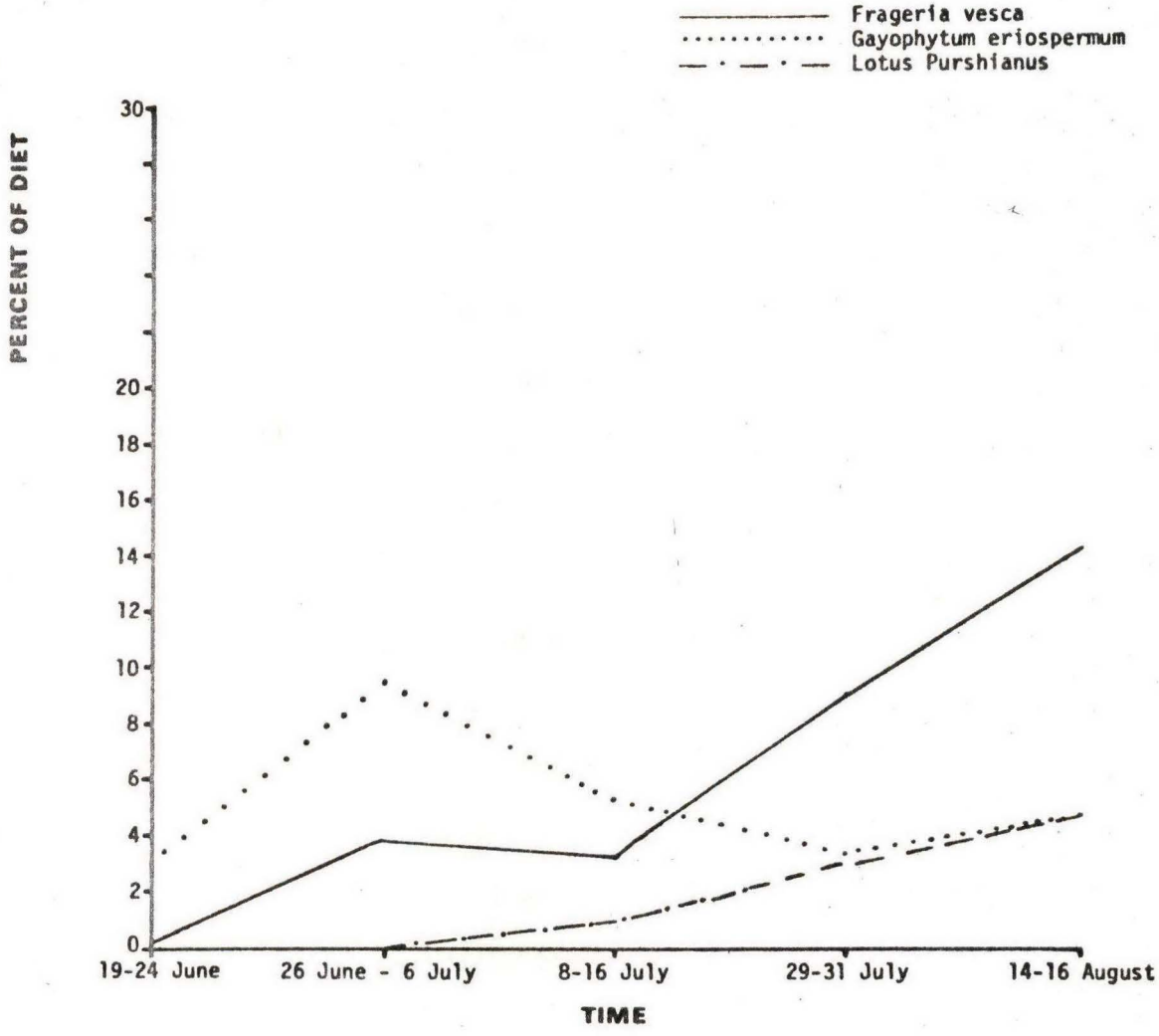
as a deer food. No information regarding deer selection of Ivesia as a forage was found in the literature. Knotweed and Ivesia were most important early in the summer and declined in importance with time (Fig. 5). Our observations indicate that cinquefoil continuously put out new growth and may have been attractive to deer throughout the season (Appendix III).

Spanish clover (Lotus Purshianus) was not important early in the season, but steadily increased in the diet with time (Fig. 6). Trefoil developed late and could be important in late summer diets of deer in Markwood Meadow. Larson (personal communication) stated that deer on the San Joaquin Experimental Range readily eat this species of Spanish clover. Strawberry (Fragaria vesca) was low in the diet at the beginning of summer and increased to about 15 percent of the diet at the end of the season (Fig. 6). Our observations indicate this species matured later than did some of the other forbs and may have remained palatable longer into the season, accounting for late season importance. Leach (1956) reported that mule deer in California ate strawberry.

Cattle were released onto the meadow on 23 June 1975 and remained throughout the sampling periods. Evidence of cattle use on vegetation was apparent soon after introduction of the herd. Ivesia and knotweed were readily eaten by the deer and also seemed to be preferred by the cattle. Our observations indicate that cattle use of plant species reduced the availability of these species for deer during the later portion of the summer. Clayton (1974) reported that virtually every plant in Markwood Meadow had been at least partially utilized within 40 to 50 days after the cattle were released. Our observations indicate that 100 percent of the plants are at least partially eaten within 21 to 28 days after introduction of cattle.

Grasses and Sedges. Pointed rush (Juncus oxymeris), 5.9 percent, and sedges (Carex spp.), 4.3 percent, were the most important species in this

Fig. 6. Important species of forbs in the diets of the tractable deer in Markwood Meadow during summer 1975.


Frageria vesca
Gayophytum eriospermum
Lotus Purshianus
PERCENT OF DIET
30
20
18
16
14
12
10
8
6
4
2
0
19-24 June
26 June - 6 July
8-16 July
29-31 July
14-16 August
TIME

general group in the total diet (Table 3). Grasses (Gramineae) never comprised more than 0.95 percent of the diet during any single sampling period. Evans et at. (1976) reported that tractable deer ate sedges and pointed rush on the winter range of the North Kings herd. Leach (1956) reported the use of sedges by deer for food. Pattee (1973) found that deer on the summer range of the North Kings herd ate sedges. Pointed rush, sedges and other plant species in this general group were eaten by cattle as well as by our deer.

Browse. Sierra gooseberry was the only important browse species in the diet in Markwood Meadow (Table 5). Its importance was low at the beginning of summer and increased with time (Fig. 7). Phenological observations indicate that forbs were drying at this time and could account for the increased use of Sierra gooseberry. Evans (1976), Jordan (1967), and Dixon (1934) have reported that Sierra gooseberry was used for food by deer in the Sierra Nevada. Western blueberry comprised 0.80 percent of the total diet but grew only in a corner of the study site and was readily eaten by the deer when they encountered this species. Wallmo et al. (1972) reported that Vaccinium scoparium and V. myrtillus were important deer foods in Colorado.

Brush Slope 1

Forage usage, pellet groups, and tracks indicated that wild deer used this site during the summers of 1974 and 1975. Late in the summer of 1975, one of us (CJE), observed fawn tracks on the study site that were not made by any of our deer. He also observed a fawn in the study area on 11 September 1975. The area and resources used by a doe to raise fawns have been described by Ashcraft as a propagation unit (Holl 1976). If fawns do utilize this study site, it could be part of a propagation unit and an important site to study deer food preferences.

Fig. 7. Important browse and sedges in the diets of the tractable deer in Markwood Meadow during summer 1975.

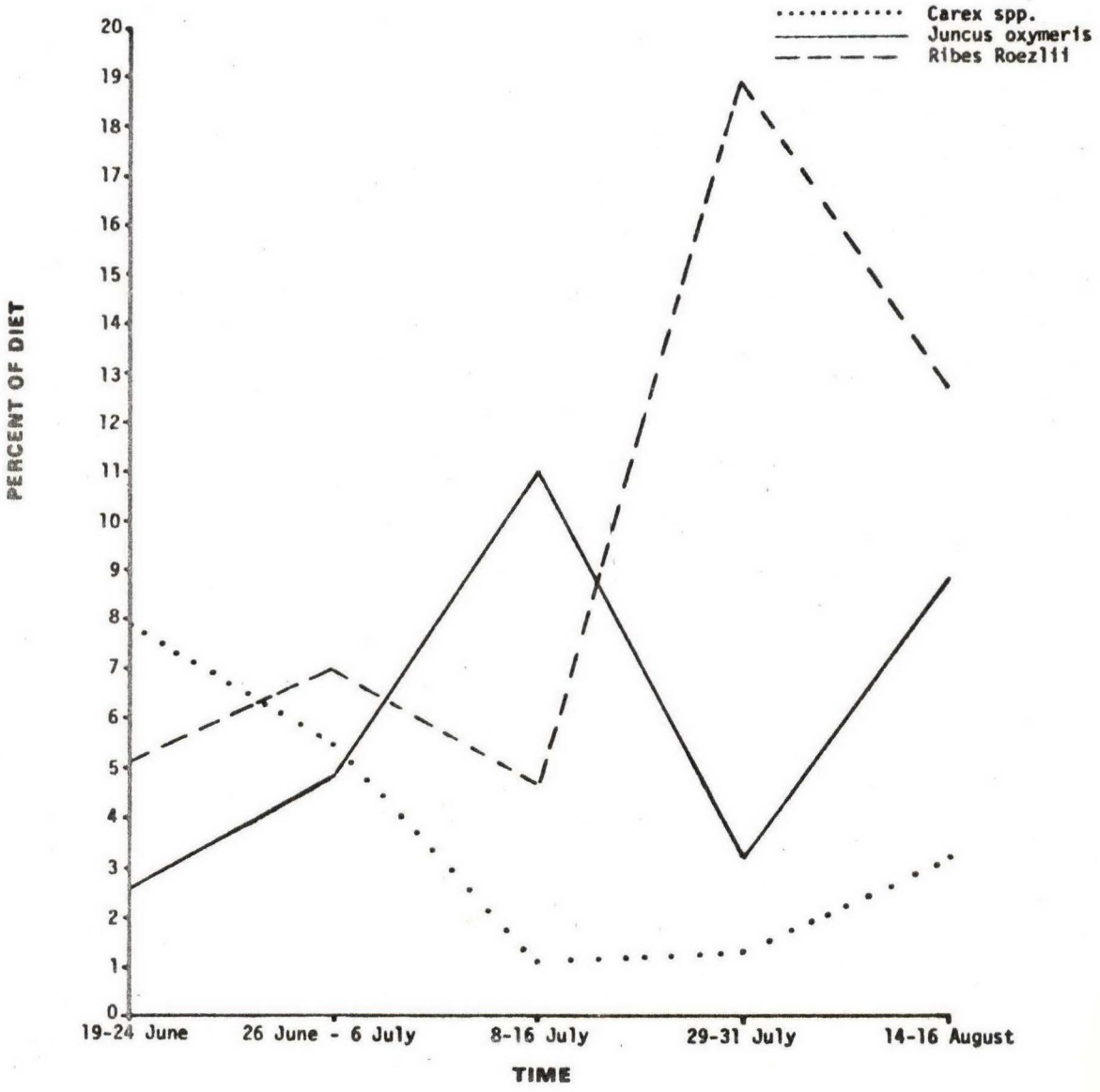

Carex spp.
Juncus oxymeris
Ribes Roezlii
PERCENT OF DIET
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
19-24 June
26 June - 6 July
8-16 July
29-31 July
14-16 August
TIME

Fig. 8. Representative vegetation on Brush Slope 1, Sierra National Forest, Fresno County, California. The photo faces southwest and was taken in July 1975.

TABLE 4

Vegetative cover of Brush Slope 1 in the Sierra National Forest, as estimated by the line intercept method

Species	Percent absolute cover	SE (N = 90)	Percent relative cover
Ceanothus cordulatus	17.56	41.48	36.18
Chrysolepis sempervirens	8.63	33.41	17.78
Lupinus longifolius	4.13	23.49	8.50
Abies concolor	3.60	15.49	7.42
Pteridium aquilinum	3.34	17.39	6.87
Prunus emarginata	2.72	9.04	5.61
rock	1.60	11.12	. . .
Ribes Roezlii	1.52	7.36	3.14
Calocedrus decurrens	1.34	8.26	2.75
Acrctostaphylos patula	1.10	8.24	2.27
Pinus Lambertiana	0.88	5.36	1.80
Hackelia mundula	0.61	3.07	1.25
logging slash	0.58	5.79	. . .
Mondarella odoratissima	0.50	3.60	1.03
Symphoricarpos acutus	0.48	5.99	1.00
Apocynum pumilum	0.43	3.54	0.90
Quercus Kelloggii	0.24	2.63	0.49
Other species	1.44	. . .	3.01
Total	50.70	65.04	100.00

TABLE 5

Diets of the yearling deer on Brush Slope 1 in the Sierra National Forest during summer 1975

Species	TIME PERIOD							
	30 June-7 July		14-30 July		14 Aug-6 Sept		Full Summer	
	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet
Ceanothus cordulatus	1,493	48.21	985	35.33	2,370	50.73	4,848	45.92
leaves	1,451	46.85	947	33.97	2,280	48.80	4,678	44.31
flowers and fruits	42	1.36	38	1.36	90	1.93	170	1.61
Chrysolepis sempervirens	458	14.79	482	17.29	290	6.21	1,230	11.65
Prunus emarginata	178	5.75	281	10.08	584	12.50	1,043	9.88
Arctostaphylos patula	181	5.85	190	6.82	181	3.87	552	5.23
leaves	161	5.20	136	4.88	145	3.10	442	4.19
flowers and fruits	20	0.65	54	1.94	36	0.77	110	1.04
Quercus Kelloggii	155	5.00	144	5.16	72	1.54	371	3.51
Pteridium aquilinum	11	0.36	42	1.51	280	5.99	333	3.16
green	11	0.36	35	1.26	221	4.73	267	2.53
dry	0	0.0	7	0.25	59	1.26	66	0.63
Corylus cornuta	129	4.17	107	3.84	79	1.69	315	2.98
Gayophytum eriospermum	50	1.61	92	3.30	62	1.33	204	1.93

TABLE 5

(Continued)

Species	TIME PERIOD							
	30 June-7 July		14-30 July		14 Aug-6 Sept		Full Summer	
	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet
Ribes Roezlii	71	2.29	20	0.72	112	2.40	203	1.93
Calystegia malacophylla	13	0.42	67	2.40	98	2.10	178	1.69
Bromus Orcuttianus	97	3.13	45	1.61	31	0.66	173	1.64
Symphoricarpos acutus	30	0.97	32	1.15	108	2.31	170	1.61
Abies concolor	19	0.61	38	1.36	94	2.01	151	1.43
green	13	0.42	29	1.04	89	1.90	131	1.24
dry	6	0.19	9	0.32	5	0.11	20	0.19
Hackelia mundula	28	0.90	16	0.57	91	1.95	135	1.28
deer pellets	50	1.61	60	2.15	15	0.32	125	1.18
Other items	134	4.32	187	6.71	205	4.39	526	4.99
Total	3,097	100.00	2,788	100.00	4,672	100.00	10,557	100.00

Brush Slope 1 is an open brush slope that was logged about 1967 (Fig. 8). It is located at the extreme northern end of the Markwood Meadow road in section 23, T9S., R25E. MDM. Small timbered areas and patches of undisturbed brush remain. The timbered patches are mainly white fir (Abies concolor) and incense cedar (Calocedrus decurrens). Logging slash had been piled and burned. Important shrub species on the site were mountain whitethorn, chinquapin, greenleaf manzanita, and Sierra gooseberry. Dominant forbs are bracken fern (Pteridium aquilinum) and gayophytum. In the disturbed areas, the brush species are low growing and 100 percent of the vegetation is available to deer. In the undisturbed areas, the browse species are dense and not all of the vegetation is available to deer. Slopes on the study site are moderately steep and range from 20 to 25 degrees.

A total of 900 m of line intercept was recorded to measure shrub cover (Table 4). Total vegetative cover was a little more than 50 percent (Table 4). Mountain whitethorn and chinquapin comprised over half of the vegetative cover. Relative cover values were calculated and used to calculate selectivity indices for important species.

Food preferences on Brush Slope 1: Yearlings

The five yearlings used to determine food preferences in Markwood Meadow were used to sample this study area. Eighteen feeding trials were conducted from 30 June to 6 September 1975. A total of 10,557 bites were recorded in 3,136 minutes of observation. The tractable deer utilized a total of 47 food items, including 43 species of vascular plants.

Browse species dominated the forage choices of the yearlings on this site (Table 5). The browse species were almost 97 percent of the diet at the beginning of the summer and then comprised from 82 to 93 percent of the diet

(Table 5). Forbs were a moderate portion of the diet and never constituted more than 15 percent of the diet. Grasses and sedges never comprised more than 2.0 percent of the diet.

Browse. Mountain whitethorn was the most important species in the total diet, comprising 45.92 percent of the total diet (Table 5). Mountain whitethorn varied between 33 and 50 percent of the diet. This species was a selected item for all sampling periods with the exception of 14 to 30 July (Table 6). Dixon (1934), Dayton (1931), Ferrel and Leach (1957), and Longhurst et al. (1952) considered mountain whitethorn an important deer food.

Bitter cherry, 9.88 percent, and chinquapin, 11.65 percent, were other important food species (Table 5). Chinquapin was important during late June and the middle of July, and then decreased in importance (Table 5). Chinquapin was not a preferred species during any of the sampling periods (Table 6). Observations indicate that new growth was available when chinquapin was important and probably influenced selection. Leach and Hiehle (1957) and Dixon (1934) reported that deer ate chinquapin.

Bitter cherry was most important during the last two sampling periods (Table 5). Dixon (1934), Russell (1932), and Longhurst et al. (1952) considered bitter cherry an important food item. Selectivity indices show bitter cherry was an preferred species, with selectivity indices ranging from 1.02 to 3.08 (Table 6). Black oak was only 3.51 percent of the total diet but was preferred during all sampling periods (Table 6). Evans (1976), Dixon (1934), and Leach (1956) have reported the importance of black oak in deer diets.

Forbs. The use of forbs does not seem to exhibit a seasonal pattern on Brush Slope 1. Gayophytum, 1.9 percent, and morning glory (Calystegia

TABLE 6

Selectivity indices for important plant species in the diet of the yearlings on Brush Slope 1 in the Sierra National Forest during summer 1975

Species	TIME PERIOD			
	30 June-7 July	14-30 July	14 Aug-6 Sept	Full Summer
Ceanothus cordulatus	1.33	0.99	1.40	1.27
Chrysolepis sempervirens	0.83	0.97	0.35	0.66
Prunus emarginata	1.02	1.80	2.23	1.76
Arctostaphylos patula	2.58	2.15	1.70	2.30
Quercus Kelloggii	10.20	10.53	3.14	7.16
Pteridium aquilinum	0.05	0.22	0.87	0.46
Corylus cornuta	1.89	1.74	0.76	1.35
Ribes Roezlii	0.73	0.23	0.76	0.61
Symphoricarpos acutus	0.97	1.15	2.31	1.61
Abies concolor	0.19	0.18	0.27	0.08

malacophylla), 1.7 percent, were 2 of the most important forbs in the total diet. These species increased sharply in the diet during mid July then declined (Table 5). Pattee (1973) and Salwasser (1974) felt that gayophytum was an important deer food on the North Kings deer herd range. No information regarding deer eating morning glory was found in the literature. Bracken fern continually increased in importance with time and comprised 3.16 percent of the total diet (Table 5). Our deer consumed both the green and dry fronds of bracken fern. Dixon (1934) and Linsdale and Tomich (1953) reported that deer ate bracken fern.

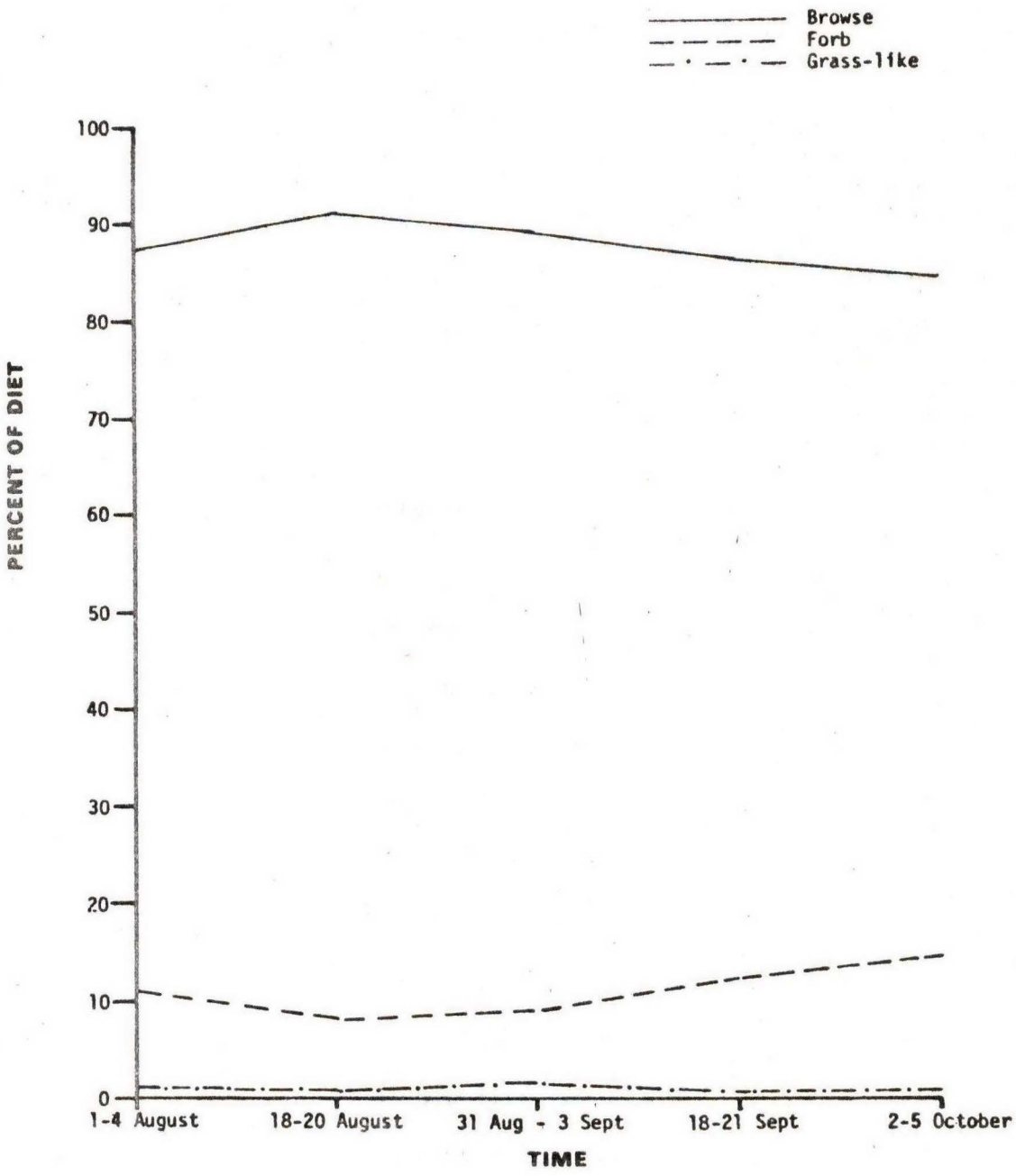
Grasses and Sedges. Brome (Bromus Orcuttianus) was the only grass to make up any significant portion of the diet (Table 5). This species steadily decreased in importance with time. The deer ate less of this species as it matured and began to flower. These findings correspond to the findings of Dixon (1934) and Evans et al. (1976) with regard to phenological condition of grasses and deer food preferences. No information on deer use of this species was found in the literature but some plants on the sample site showed evidence of utilization by wild deer.

Food Preferences on Brush Slope 1: Fawns

The 11 fawns raised by us in the summer of 1975 were also used to sample forage preferences on this site. Forty feeding trials were conducted in six discrete sampling periods from 1 August to 5 October 1975. This sampling effort resulted in collection of 13,134 bites in 3,371 minutes of observation. The tractable deer fawns ate 47 food items, including 43 species of vascular plants.

Browse species made up between 85 and 90 percent of the fawns diet (Fig. 9). Forbs made up 8 to 14 percent of the diet and increased slightly at the end of the season (Fig. 9).

Fig. 9. Diet of the fawns on Brush Slope 1 in summer 1975, as broken down into three major forage classes.


Browse
Forb
Grass-like
100
90
80
70
60
50
40
30
20
10
0
PERCENT OF DIET
1-4 August
18-20 August
31 Aug - 3 Sept
18-21 Sept
2-5 October
TIME

Browse. Mountain whitethorn was the most important species in the diet, comprising 54.2 percent of the total (Table 7). Initially, it made up just over 60 percent of the diet and declined to 40 to 50 percent of the diet in the latter parts of the summer (Fig. 10). Mountain whitethorn was preferred during all sampling periods and had selectivity indices ranging from 1.25 to 1.71 (Table 8).

Other browse species generally comprised less than 10 percent of the diet during any one sampling period (Fig. 10). Sierra gooseberry, snowberry, and bitter cherry increased during late August and September when the importance of mountain whitethorn was decreasing (Fig. 10). The increases in these species are probably related to the decrease in mountain whitethorn, but no cause-effect relation is readily evident to us. Sierra gooseberry was a preferred species and had selectivity indices ranging from 2.55 to 3.36 (Table 8). Evans (1976) reported a decline in use of Sierra gooseberry when the new growth of other species emerged, but no decline occurred during this study. Jordan (1967), Dixon (1934), and Salwasser (1974) have reported that deer eat Sierra gooseberry. Snowberry was always a preferred item, and accounted for 4.99 percent of the total diet. Selectivity indices for this species ranged from 2.78 to 8.92 (Table 8). Kufeld et al. (1973) reported that other species of snowberry (Symphoricarpos spp.) were eaten by mule deer. Bitter cherry was not a preferred species except during late September when it comprised 7.32 percent of the diet (Table 7) and had a selectivity index of 1.30 (Table 8). Black oak made up only 1.55 percent of the total diet but was preferred during all sampling periods except in early August. Selectivity indices for this species ranged from 0.06 to 7.88 (Table 8). Dixon (1934) and Evans (1976) reported that black oak was a preferred deer food.

TABLE 7

Diet of the fawns on Brush Slope 1 in the Sierra National Forest, during summer 1975

Species	Bites	Percent of Diet
Ceanothus cordulatus	7,119	54.20
leaves	7,016	53.42
flowers and fruits	103	0.78
Ribes Roezlii	1,168	8.89
Symphoricarpos acutus	655	4.99
Abies concolor	550	4.19
green leaves	478	3.64
dry leaves	72	0.55
Prunus emarginata	530	4.04
Pteridium aquilinum	519	3.95
green	482	3.67
dry	37	0.28
Chrysolepis sempervirens	398	3.03
Arctostaphylos patula	389	2.96
leaves	384	2.92
flowers and fruits	5	0.04
Gayophytum eriospermum	376	2.86
Calystegia malacophylla	232	1.77
Quercus Kelloggii	204	1.55
Miscellaneous shrubs	199	1.52
Other food items	795	6.05
Total	13,134	100.00

Fig. 10. Important browse species in the diets of the fawns on Brush Slope 1 during summer 1975.

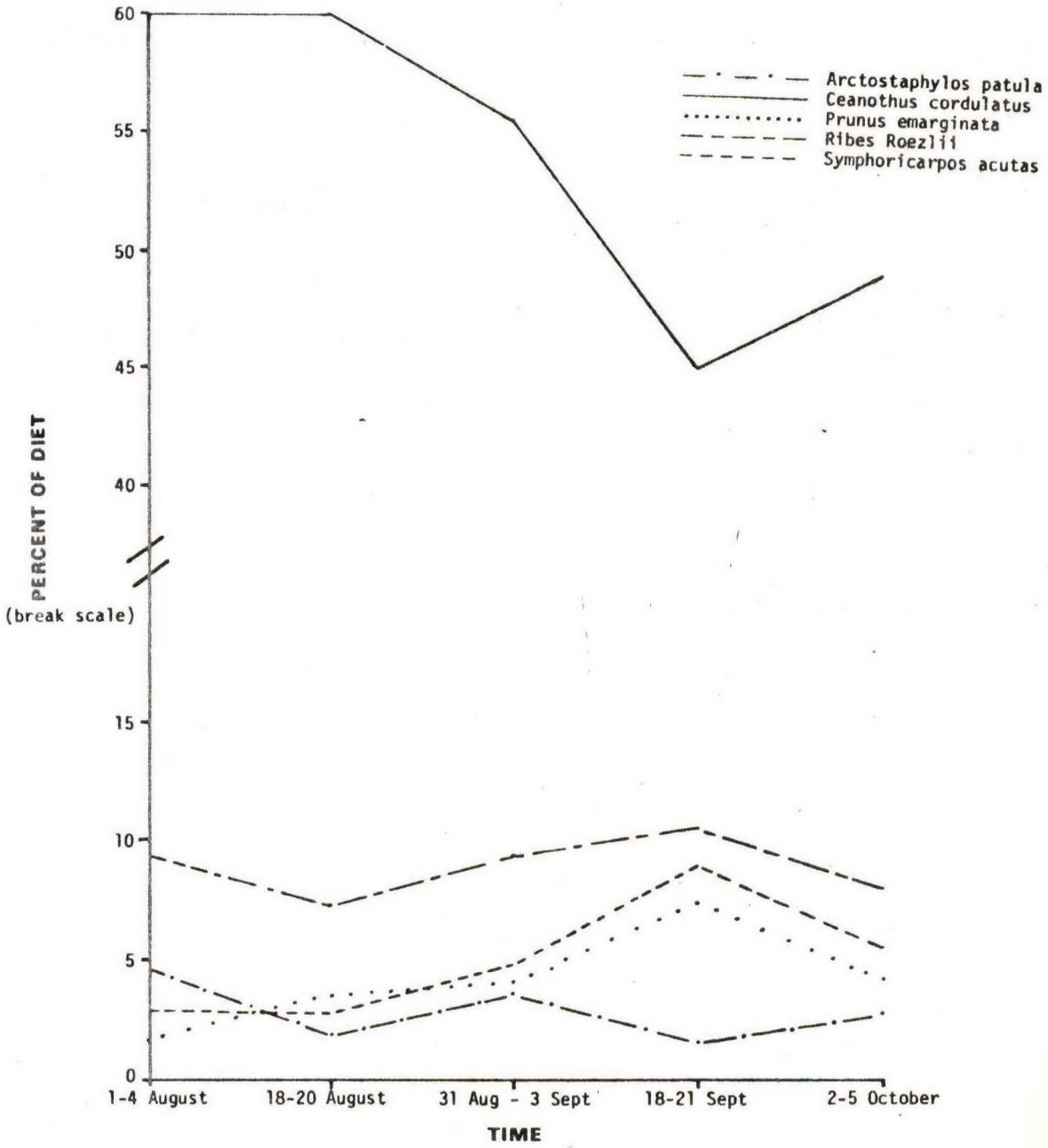

60
55
50
45
40
15
10
5
0
PERCENT OF DIET
(break scale)
Arctostaphylos patula
Ceanothus cordulatus
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas
1-4 August
18-20 August
31 Aug - 3 Sept
18-21 Sept
2-5 October
TIME

TABLE 8

Selectivity indices for important plant species eaten by the fawns on Brush Slope in the Sierra National Forest during summer 1975

Species	TIME PERIOD					
	1-4 Aug	14-21 Aug	31 Aug-3 Sept	18-21 Sept	2-5 Oct	Full Summer
Ceanothus cordulatus	1.71	1.68	1.54	1.25	1.34	1.50
Ribes Roezlii	2.97	2.35	2.99	3.36	2.55	2.83
Symphoricarpos acutus	2.88	2.78	4.86	8.92	5.56	4.99
Abies concolor	0.41	0.58	0.68	0.54	0.64	0.56
Prunus emarginata	0.28	0.63	0.73	1.30	0.75	0.72
Pteridium aquilinum	0.38	0.23	0.26	0.43	1.23	0.57
Chrysolepis sempervirens	0.10	0.16	0.15	0.24	0.20	0.17
Arctostaphylos patula	4.62	0.85	1.58	0.69	1.21	1.30
Quercus Kelloggii	0.06	7.88	2.82	1.71	4.20	3.16

Forbs and Grasses. Forbs eaten by the fawns on Brush Slope 1 formed a fairly constant portion of the diet (Fig. 11). Gayophytum and morning glory were fairly constant in the diet from August through October and do not seem to exhibit any real change throughout the season (Fig. 11). Bracken fern was a fairly constant portion of the diet until early October when it increased to about 8.5 percent of the diet (Fig. 11). Bracken fern was not a preferred species with the exception of early October when it had a selectivity index of 1.23 (Table 8). The fawns consumed both green and dry fronds of bracken fern. Grasses (Gramineae) never made up more than 0.25 percent of the diet (Fig. 9).

Description of the Lupine Area sample site.

The Lupine Area was part of the home range of a doe that gave birth to twin fawns in 1974 and 1975. There is little doubt that the Lupine Area is used by this particular doe to raise fawns. As part of a propagation unit, the Lupine Area is an important area in which to study fawn food habits. The Lupine Area is located about 0.4 km south of Stevenson Creek on the Markwood Meadow road in section 26, T9S., R25E. MDM. (Fig. 2). This sample site is at an elevation of about 2,060 m (6759 Ft) and is mostly level but contains some slopes up to 20 degrees. The Lupine Area was clearcut between 1964 and 1967. The slash from logging had been piled and burned.

Vegetation of the area is predominately shrubs, with a few small tree seedlings (Fig. 12). Predominate shrubs on this site were mountain whitethorn, littleleaf ceanothus (Ceanothus parvifolius), lupine (Lupinus latifolius), and Sierra gooseberry. Common herbs in the area were fireweeds (Epilobium spp.), hairgrass (Deschampsia caespitosa), gayophytum, and trefoil (Lotus oblongifolius). A total of 630 m of line intercept were recorded to measure vegetation on this

Fig. 11. Important forb species in the diets of the fawns on Brush Slope 1 during summer 1975.

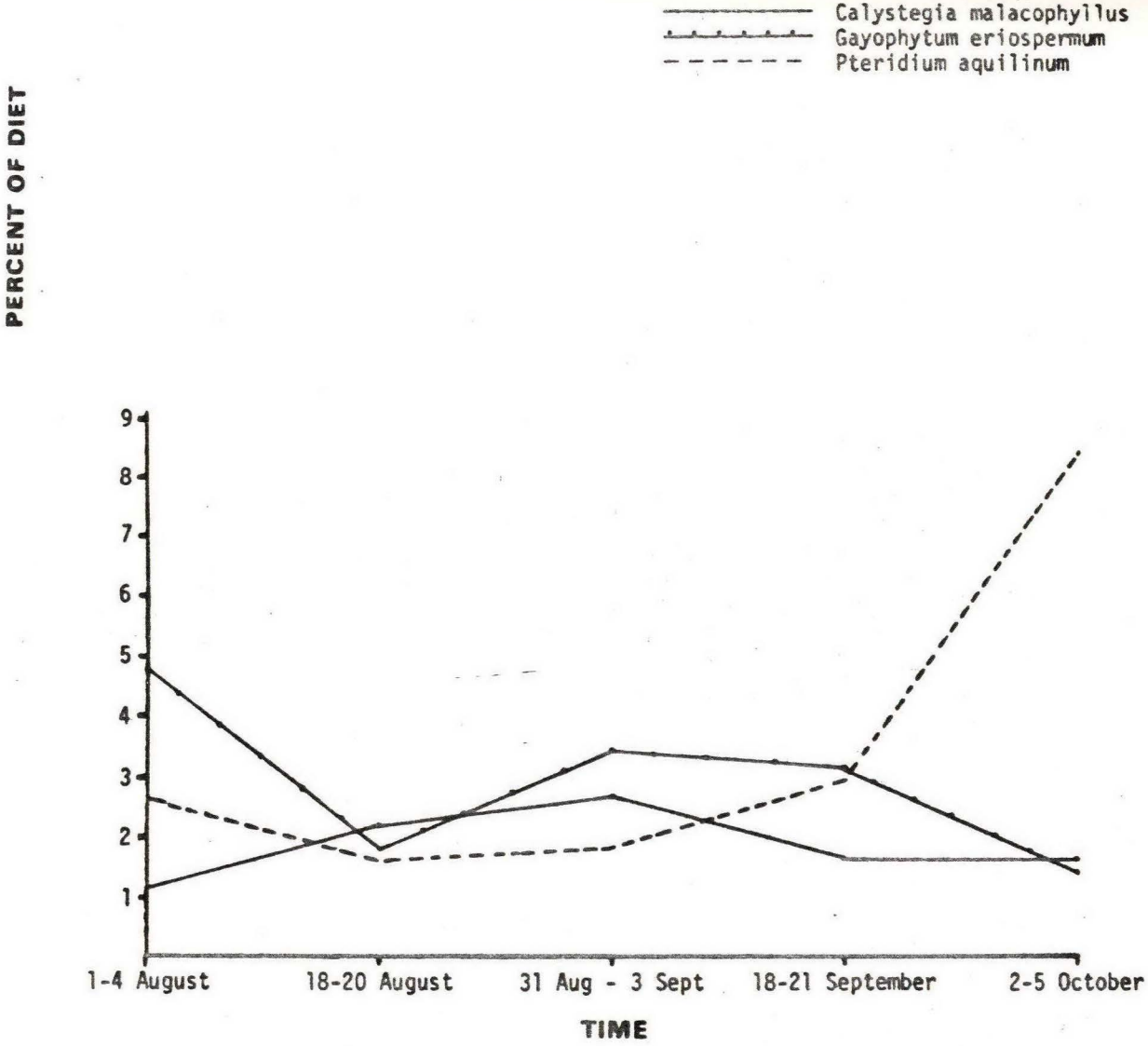

Calystegia malacophyllus
Gayophytum eriospermum
Pteridium aquilinum
PERCENT OF DIET
9
8
7
6
5
4
3
2
1
1-4 August
18-20 August
31 Aug - 3 Sept
18-21 September
2-5 October
TIME

Fig. 12. Representative vegetation of the Lupine Area, Sierra National Forest. The photo faces west and was taken in July 1975.

site (Table 9). Relative cover and selectivity indices were calculated from the line intercept data.

All 11 fawns raised and trained by us during the summer of 1975 were used to determine food preferences in the Lupine Area. We were interested in fawn food preferences in this area so the yearling deer were not used. Fifteen feeding trials were conducted on this site between 18 August and 14 September 1975. A total of 6,595 bites were recorded in 1,831 minutes of observation.

Browse species were most important in the diet of fawns on this study site, comprising about 80 percent of the total diet (Table 10). Forbs were most important in late August and early September when they composed about 25 percent of the diet (Table 10). Grasses and sedges never made up more than 5 percent of the diet.

Mountain whitethorn was by far the most important species in the diet (Table 10). It comprised about 55 percent of the diet during the first periods and declined to about 45 percent of the diet in late summer (Table 10). Mountain whitethorn was always a preferred species and had selectivity indices ranging from 1.5 to 1.8 (Table 11). Littleleaf ceanothus was a small part of the diet initially, but increased in importance to about 10 percent of the diet (Table 10). The increase in use of littleleaf ceanothus almost exactly matches the decline of mountain whitethorn in the diet (Table 10). Observations indicate that littleleaf ceanothus developed substantial new growth later in the season than did mountain whitethorn. We feel enough new growth to influence the tractable deer diets was available only during the latter stages of the summer. Littleleaf ceanothus was always a preferred species and had selectivity between 1.55 and 10.49 (Table 11). Dixon (1934) reported that deer used littleleaf ceanothus a "fair amount." No other browse species made

TABLE 9

Vegetative cover on the Lupine Area in the Sierra National Forest as measured by the line intercept method

Species	Absolute cover	SE (N = 42)	Relative cover
Ceanothus cordulatus	22.16	51.36	29.53
Pteridium aquilinum	14.90	60.26	19.85
Lupinus latifolius	12.03	36.72	16.04
Ribes nevadense	9.13	27.61	12.17
SLASH	8.12	31.27	. . .
Arctostaphylos patula	3.70	16.61	4.94
Chrysolepis sempervirens	3.66	18.30	4.88
ROCK	2.75	31.27	. . .
Pinus Jeffreyi	1.57	5.78	2.09
Solanum Xantii	0.73	5.44	0.97
Carex sp.	0.72	6.68	0.96
Symphoricarpos acutus	0.71	6.73	0.95
Ceanothus parvifolius	0.70	4.00	0.94
Salix sp.	0.57	5.51	0.76
Sambucus caerulea	0.56	4.34	0.74
Phacelia mutabilis	0.52	1.94	0.69
Lotus crassifolius	0.52	7.73	0.69
Ribes Roezlii	0.43	2.92	0.57
Potentilla glandulosa	0.36	1.51	0.48
Rubus parviflorus	0.34	2.97	0.46
Chrysopsis Breweri	0.33	2.80	0.44

TABLE 9

(Continued)

Species	Absolute cover	SE (N = 42)	Relative cover
Bromus Orcuttianus	0.23	2.01	0.30
Abies concolor green	0.20	2.95	0.26
dry	0.03	0.50	0.04
Lotus oblongifolius	0.21	1.97	0.27
Apocynum pumilum	0.17	2.16	0.22
Other species	0.53	73.97	0.68
Total	85.88		100.00

TABLE 10

Diets of the fawns on the Lupine Area in the Sierra National Forest during summer 1975

Species	TIME PERIOD							
	18-20 Aug		21 Aug-2 Sept		11-14 Sept		Full Summer	
	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet
Ceanothus cordulatus	1,218	55.19	985	53.47	1,144	44.93	3,347	50.75
leaves	1,176	53.29	985	53.47	1,143	44.89	3,304	50.10
flowers and fruits	42	1.90	0	0.00	1	0.04	43	0.65
Pteridium aquilinum	231	10.47	210	11.40	207	8.13	648	9.82
green fronds	192	8.70	200	10.86	197	7.74	589	8.93
dry fronds	39	1.77	10	0.54	10	0.39	59	0.89
Ceanothus parvifolius	26	1.18	41	2.23	251	9.86	318	4.82
Potentilla glandulosa	52	2.36	109	5.92	75	2.95	236	3.58
Juncus oxymeris	88	3.99	55	2.99	68	2.67	211	3.20
Gayophytum eriospermum	92	4.17	95	5.16	11	0.43	198	3.00
Salix spp.	16	0.72	41	2.23	103	4.05	160	2.43
Pinus Jeffreyi	67	3.04	16	0.87	66	2.59	149	2.26
Chrysolepis sempervirens	26	1.18	25	1.36	84	3.30	135	2.05

TABLE 10

(Continued)

Species	TIME PERIOD							
	18-20 Aug		21 Aug-2 Sept		11-14 Sept		Full Summer	
	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet	Bites	Percent Diet
Pinus Lambertiana	41	1.86	31	1.68	59	2.32	131	1.99
Lupinus latifolius	40	1.81	39	2.12	48	1.89	127	1.93
Lotus oblongifolius	27	1.22	17	0.92	54	2.12	98	1.49
Arctostaphylos patula	14	0.63	42	2.28	38	1.49	94	1.43
Other species	269	12.19	136	7.38	308	12.10	743	11.27
Total	2,207	100.00	1,842	100.00	2,546	100.00	6,595	100.00

TABLE 11

Selectivity indices of important plant species in the diet of the fawns on the Lupine Area in the Sierra National Forest during summer 1975

Species	TIME PERIOD			
	18-20 Aug	21 Aug-2 Sept	11-14 Sept	Full Summer
Ceanothus cordulatus	1.87	1.81	1.52	1.72
Pteridium aquilinum	0.53	0.57	0.41	0.49
Ceanothus parvifolius	1.26	2.37	10.49	5.13
Potentilla glandulosa	4.92	12.33	6.15	7.46
Salix spp.	0.87	2.69	4.88	3.20
Pinus Jeffreyi	1.45	0.42	1.24	1.08
Chrysolepis sempervirens	0.24	0.28	0.68	0.42
Pinus Lambertiana	50.00	84.00	116.00	99.50
Lupinus latifolius	0.11	0.13	0.12	0.12
Arctostaphylos patula	0.13	0.46	0.30	0.29

Select index = % of sp. in diet / % relat. cover of that sp.

up more than 2.26 percent of the total diet (Table 10).

Willows (Salix supp.), 2.43 percent of the total diet, were preferred during late September and early October when selectivity indices were 4.88 and 2.69 (Table 11). Dixon (1934), Longhurst et al. (1952), and Leopold et al. (1951) reported that deer ate willows.

Forbs. Bracken fern, cinquefoil, and gayophytum were important in the diet during early and middle August and then declined (Table 10). Bracken fern was still about 8 percent of the diet in early September, but cinquefoil and gayophytum were less than 5 percent of the diet (Table 10). Although bracken fern was always the second or third most important species in the diet, it was not a preferred species, and never had a selectivity index greater than 0.6 (Table 11). Cinquefoil was always preferred and had selectivity indices greater than 4.92 and 12.33. Trefoil comprised about 1 percent of the diet for early and middle August and then increased to over 2 percent of the diet (Table 10). Observations indicate that trefoil occurred in the relatively moist areas on the site and may continually increase in importance in late summer.

Grasses and Sedges. Pointed rush was the only important species in this group and made up 3.20 percent of the total diet (Table 10). Pointed rush comprised about 4 percent of the diet during early August and declined with time (Table 10).

Because we sampled this area for only about a month, the results do not show a complete summer pattern of seasonal forage selection. However, the forage choices on this area were consistent with the corresponding phenology conditions and our data from the other study sites.

Stringer Meadow

Stringer Meadow was used as a training site for the fawns in 1974 and 1975. Little use by wild deer was recorded from this area. Our observations

showed little use on forage, and only one sighting of wild deer was recorded.

Stringer Meadow is located near the Markwood Meadow road in section 26, T9S., R25E., MDM. at an elevation of about 2,060 m. This study site is a small meadow bordered by mature forest. Some of the predominant species in the meadow were trefoil, bracken fern, western oxypolis (Oxypolis occidentalis), Bigelow sneezeweed (Helenium Bigelovii), aster (Aster foliaceous), pearly everlasting (Anaphalis margaritacea), sedges, Scouler willow (Salix Scouleriana), and Gairdner's Yampah (Perideridia Gairdneri).

Six of the 11 fawns raised in 1975 were used to sample food preferences on this study site. Four feeding trials were conducted on 6 and 7 September 1975. A total of 559 bites was recorded in 362 minutes of observation.

Forbs were the dominant species in the diets of the fawns on this site. Bracken fern was the most important species in the diet and comprised 39.18 percent of the diet (Table 12). White fir, 9.12 percent, Scouler willow, 8.23 percent, and rush (Juncus macrandrus), 7.69 percent, were other important species in the fawn diet. Other species that comprised more than 3 percent of the diet were Sierra gooseberry, trefoil, and knotweed (Table 12).

Diet preferences of deer: 1974 vs. 1975

A comparison of the total diet of the fawns from Brush Slope 1 in 1975 and the total diet of the yearlings from Brush Slope 1 in 1975 indicates no significant differences (Table 13). The total diet for each age class indicates similar trends but the exact species composition of the diet is not identical. Further comparison of fawn diets and yearling diets from the same phenological conditions in 1975 would undoubtedly indicate a much greater correlation than the comparison of the total diets. Wallmo et al. (1972) reported no significant differences in diets between the age classes of their tractable deer.

TABLE 12

Diet of the tractable deer fawns in Stringer Meadow, Sierra National Forest, during summer 1975

Species	Bites	Percent of Diet
Pteridium aqulinum	227	40.61
green	219	39.18
dry	8	1.43
Abies concolor	51	9.12
green	37	6.62
dry	14	2.50
Salix Scouleriana	46	8.23
Juncus macrandrus	43	7.69
Rumex angiocarpus	30	5.37
Lotus oblongifolius	25	4.47
Ribes Roezlii	19	3.40
Madia Bolanderi	15	2.68
Achillea lanulosa	10	1.79
Chrysolepis sempervirens	9	1.61
Helenium Bigelovii	9	1.61
Potentilla glandulosa	9	1.61
Pinus Jeffreyi	8	1.43
Veratrum californicum	8	1.43
Aster foliaceous	7	1.25
Dodecatheon Jeffreyi	6	1.07
Pinus Lambertiana	6	1.07
misc. herbaceous	27	4.83
misc. non-herbaceous	4	0.72
TOTAL	559	99.62

TABLE 13

Comparison of diets of the tractable deer from 1974 and 1975 in the Sierra National Forest

Comparison	Calculated Spearman's *rho*	Degrees of freedom	Significance level
Brush Slope 1			
Yearlings (1975)			
X			
Fawns (1975)	.697	20	$P < .05$
Fawns (1974)			
X			
Fawns (31 Aug-3 Sept 1975)	.627	9	$P < .05$
Stringer Meadow			
Fawns (1974)			
X			
Fawns (1975)	.140	18	$P < .05$
Lupine Area			
Fawns (1974)			
X			
Fawns (11-14 Sept 1975)	.716	15	$P < .95$

Mountain whitethorn was the most important species in the diets of both the fawns and the yearlings and a preferred species for both age classes of tractable deer. Sierra gooseberry, snowberry, bitter cherry, and bracken fern were also important species to both age classes of deer.

Snowberry and black oak were preferred by both the fawns and yearlings. Sierra gooseberry was preferred by the fawns but not by the yearling deer. Bitter cherry was preferred by the yearlings but not by the fawns. Greenleaf manzanita was preferred by the yearlings but varied between preferred and non-preferred by the fawns. Bracken fern was not preferred by either age class.

A comparison of the bite data for 1974 from Brush Slope 1 and fawns bite data from the corresponding phenological period for 1975, 31 August to 3 September, indicates no significant differences. A comparison of the bite data from the Lupine Area for 1974 and the bite data from the corresponding phenological period for 1975, 11 to 14 September, indicates no significant differences. A comparison of bite data for 1974 and data from 1975 for the corresponding phenology period, 6 and 7 September, indicates the diets were significantly different (Table 13). Trefoil, Scouler willow, chinquapin, and mountain whitethorn were the most important species in the diet of the fawns from 1974 (Chesemore 1975). Scouler willow and trefoil were the only species that were important in both years.

The comparison of the diets from the brushy study sites indicate a similarity in forage selection between age classes of tractable deer and between seasons. While the comparison of the two years of data from Stringer Meadow do not indicate correlation of diets, these data are limited and may not accurately reflect forage choices of tractable deer.

NUTRITIONAL VALUES OF FORAGES

Hagen (1953) points out that most deer that die of malnutrition do so with full rumens. Therefore, a knowledge of forage composition is needed as well as plant availability to assess range quality.

Protein

In general, protein is considered to be the best index of nutritive value (Hagen 1953, Bissell and Strong 1955, Dietz 1971). Crude protein values ranged from a low of 7.0 percent for greenleaf manzanita on 28 October to 23.8 percent for bitter cherry on 7 August (Table 14 and Fig. 13). Crude protein values tend to be highest during the early part of the growing season and decline with time (Fig. 13). This pattern is similar to the pattern reported by Helmers (1940), Reynolds and Sampson (1943), Spinner and Bishop (1950), Bissell and Strong (1955), Smith et al. (1956), Snyder (1961), Dietz (1965, 1971).

Serious deficiencies of dietary protein result in the failure of the body to maintain itself. A slight protein deficiency will affect reproduction, lactation, growth, fat deposition, and antler development (French et al. 1956, McEwen et al. 1957, Dietz 1971). The digestibility of forage affects the amount of protein and other nutrients that can be utilized by a ruminant. Forage digestibility will be discussed in a later section.

Crude protein levels for all eight species were high enough to meet the minimum requirements for maintenance as established by Einarsen (1946), Longhurst et al. (1952), Bissell and Strong (1955), French et al. (1956), and McEwen et al. (1957). The maintenance levels for crude protein reported by these workers ranged from 4 to 7 percent. Intermediate growth and development was reported by French et al. (1956) to require 10 to 13 percent. Only greenleaf manzanita and chinquapin were below the intermediate level for any

TABLE 14

Percent Chemical Composition of Forage (Oven-Dry Basis) on Brush Slope 1 in the Sierra National Forest

Forage	Date of Collection	Crude Protein	Crude Fat	Acid Detergent Fiber	Ash	Phosphorus	Calcium	Moisture
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean
Greenleaf manzanita (*Arctostaphylos patula*)	24 Jul	12.6 ± 0.79	2.3 ± 0.38	23.8 ± 1.35	3.2 ± 0.11	0.25 ± 0.004	0.43 ± 0.023	203.0
	7 Aug	9.1 ± 0.32	2.6 ± 0.40	32.3 ± 1.19	3.5 ± 0.20	0.18 ± 0.004	0.61 ± 0.022	164.6
	21 Aug	9.2 ± 0.70	2.5 ± 0.54	29.0 ± 0.33	2.8 ± 0.33	0.13 ± 0.017	0.68 ± 0.035	155.1
	4 Sept	8.7 ± 0.61	3.3 ± 1.19	44.3 ± 2.82	3.0 ± 0.41	0.13 ± 0.004	0.64 ± 0.036	134.8
	18 Sept	7.5 ± 0.29	7.8 ± 0.30	32.3 ± 1.72	2.4 ± 0.05	0.14 ± 0.005	0.63 ± 0.057	109.2
	2 Oct	7.2 ± 0.19	7.3 ± 0.31	32.4 ± 1.38	2.3 ± 0.05	0.13 ± 0.008	0.62 ± 0.035	97.6
	28 Oct	7.0 ± 0.11	7.9 ± 0.44	33.8 ± 4.73	2.3 ± 0.19	0.13 ± 0.008	0.56 ± 0.018	88.0
Chinquapin (*Chrysolepis sempervirens*)	24 Jul	11.0 ± 0.49	4.9 ± 0.53	23.5 ± 1.14	2.3 ± 0.22	0.18 ± 0.007	0.36 ± 0.028	151.3
	7 Aug	10.3 ± 0.44	4.2 ± 0.41	26.0 ± 1.71	2.1 ± 0.32	0.16 ± 0.008	0.37 ± 0.028	177.8
	21 Aug	9.2 ± 0.27	4.2 ± 1.07	32.3 ± 0.55	1.2 ± 0.23	0.10 ± 0.004	0.28 ± 0.011	123.2
	4 Sept	9.8 ± 0.15	2.2 ± 0.18	35.6 ± 0.91	2.0 ± 0.28	0.13 ± 0.005	0.36 ± 0.018	129.4
	18 Sept	9.0 ± 0.15	4.0 ± 0.94	34.6 ± 1.27	1.9 ± 0.17	0.11 ± 0.000	0.45 ± 0.028	104.1
	2 Oct	9.8 ± 0.40	3.0 ± 0.25	35.0 ± 1.48	1.9 ± 0.15	0.10 ± 0.008	0.34 ± 0.004	97.6
	28 Oct	8.7 ± 0.24	4.5 ± 1.08	35.8 ± 1.27	2.0 ± 0.15	0.10 ± 0.005	0.50 ± 0.054	81.8
Mountain whitethorn (*Ceanothus cordulatus*) New growth	24 Jul	20.1 ± 0.43	2.2 ± 0.66	25.0 ± 2.61	4.6 ± 0.18	0.27 ± 0.000	0.80 ± 0.010	130.4
	7 Aug	20.4 ± 0.64	2.0 ± 0.27	30.4 ± 2.77	4.2 ± 0.50	0.24 ± 0.015	0.77 ± 0.13	140.4
	21 Aug	20.3 ± 0.58	2.2 ± 0.36	27.0 ± 3.88	4.9 ± 0.14	0.24 ± 0.011	0.99 ± 0.065	145.1
	4 Sept	19.7 ± 0.27	2.8 ± 0.39	26.8 ± 2.83	4.7 ± 0.09	0.21 ± 0.005	1.0 ± 0.053	151.3
	18 Sept	19.5 ± 0.41	3.2 ± 0.12	28.0 ± 1.84	3.2 ± 0.13	0.23 ± 0.078	0.75 ± 0.045	143.9
	2 Oct	17.6 ± 0.22	3.1 ± 0.23	28.3 ± 0.74	2.8 ± 0.13	0.18 ± 0.005	0.71 ± 0.035	120.3
	28 Oct	16.2 ± 0.72	3.4 ± 0.16	25.0 ± 1.40	2.8 ± 0.13	0.17 ± 0.005	0.79 ± 0.036	107.5

TABLE 14

(Continued)

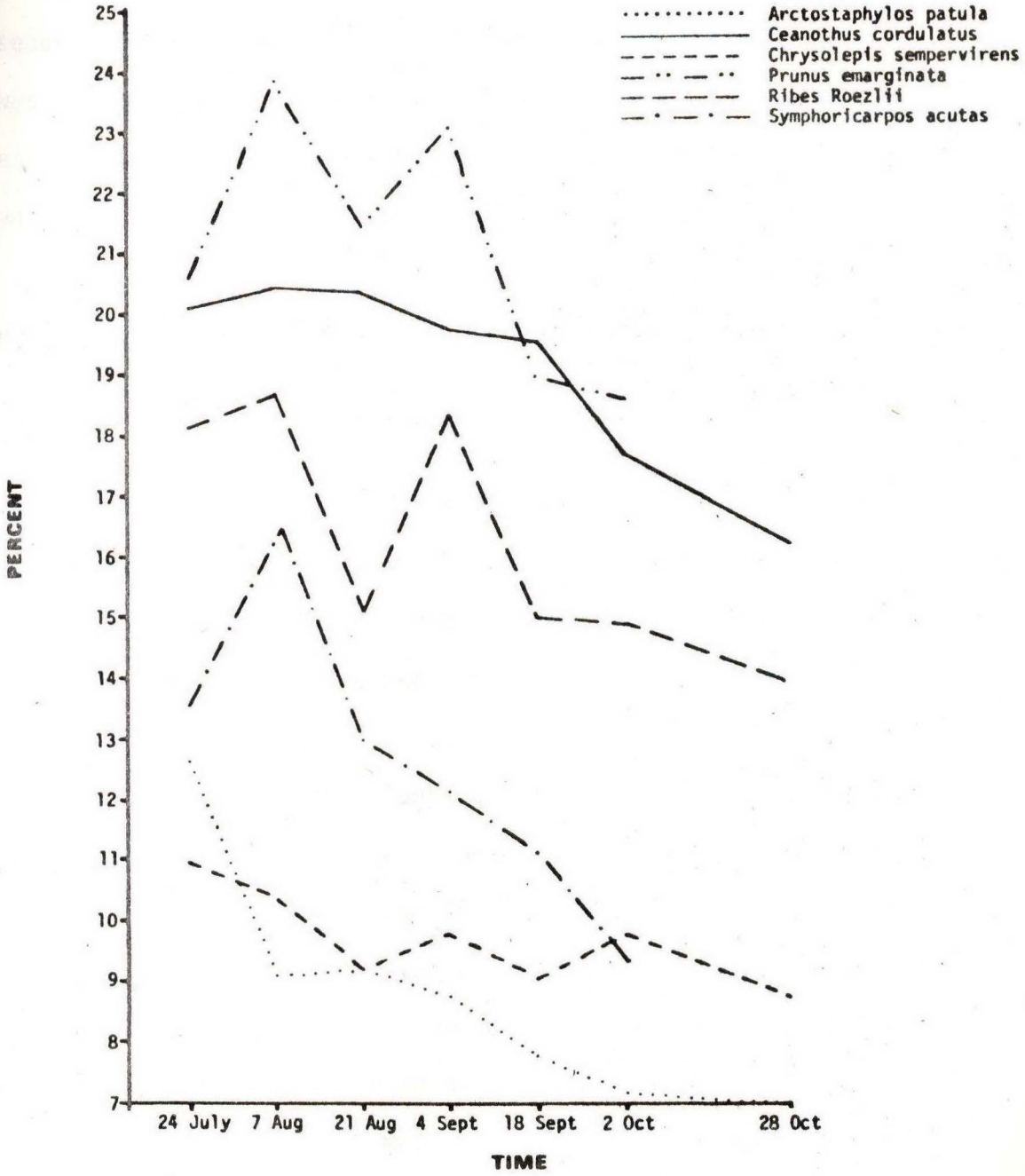
Forage	Date of Collection	Crude Protein	Crude Fat	Acid Detergent Fiber	Ash	Phosphorus	Calcium	Moisture
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean
Mountain whitethorn (Ceanothus cordulatus) Old growth	24 Jul	16.4 ± 1.05	3.8 ± 0.65	26.0 ± 1.32	3.7 ± 0.24	0.16 ± 0.013	1.4 ± 0.089	121.2
Hazelnut (Corylus cornuta)	24 Jul	14.9 ± 0.44	4.4 ± 0.72	30.2 ± 1.71	3.8 ± 0.19	0.17 ± 0.017	1.0 ± 0.054	118.3
	7 Aug	15.0 ± 0.42	4.0 ± 1.22	29.2 ± 2.05	6.5 ± 0.23	0.23 ± 0.031	1.5 ± 0.054	146.3
	21 Aug	14.4 ± 0.28	4.6 ± 1.20	25.6 ± 1.15	5.8 ± 0.30	0.22 ± 0.024	1.2 ± 0.13	126.2
	4 Sept	12.7 ± 0.21	4.3 ± 0.75	26.5 ± 1.88	4.8 ± 1.36	0.19 ± 0.013	1.1 ± 0.17	134.8
	18 Sept	13.1 ± 0.40	3.9 ± 0.14	23.8 ± 2.81	6.0 ± 0.27	0.17 ± 0.018	1.3 ± 0.054	146.3
	2 Oct	11.0 ± 0.31	4.1 ± 0.38	26.1 ± 0.92	6.0 ± 0.49	0.18 ± 0.008	1.5 ± 0.054	160.4
Bitter cherry (Prunus emarginata)	24 Jul	20.6 ± 1.54	4.3 ± 0.56	11.9 ± 0.65	7.5 ± 0.51	0.53 ± 0.049	1.5 ± 0.089	151.3
	7 Aug	23.8 ± 0.40	3.0 ± 0.46	14.7 ± 1.08	7.2 ± 0.04	0.51 ± 0.008	1.2 ± 0.070	190.7
	21 Aug	21.4 ± 0.42	2.6 ± 0.39	11.8 ± 0.67	7.4 ± 0.13	0.51 ± 0.021	1.1 ± 0.000	199.4
	4 Sept	23.0 ± 0.83	2.0 ± 0.76	12.8 ± 0.10	7.8 ± 0.55	0.53 ± 0.067	1.1 ± 0.044	191.1
	18 Sept	18.9 ± 0.36	6.1 ± 0.15	14.4 ± 2.55	7.5 ± 0.22	0.47 ± 0.018	1.6 ± 0.054	191.7
	2 Oct	18.5 ± 0.34	6.7 ± 0.28	14.0 ± 3.07	9.6 ± 0.19	0.55 ± 0.032	2.5 ± 0.063	190.7

TABLE 14

(Continued)

Forage	Date of Collection	Crude Protein	Crude Fat	Acid Detergent Fiber	Ash	Phosphorus	Calcium	Moisture
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean
Black oak (Quercus Kelloggii)	24 Jul	13.2 ± 0.23	2.6 ± 0.64	29.2 ± 1.22	3.4 ± 0.19	0.17 ± 0.005	0.69 ± 0.077	76.1
	7 Aug	14.8 ± 0.22	1.8 ± 0.77	29.8 ± 1.86	4.1 ± 0.60	0.20 ± 0.011	0.84 ± 0.19	125.2
	21 Aug	14.7 ± 0.31	1.5 ± 0.23	31.5 ± 1.20	3.7 ± 0.23	0.19 ± 0.012	0.76 ± 0.059	99.2
	4 Sept	14.6 ± 0.43	1.6 ± 0.25	28.7 ± 2.48	4.5 ± 0.17	0.18 ± 0.025	0.90 ± 0.098	111.0
	18 Sept	14.4 ± 0.38	2.6 ± 0.19	28.7 ± 1.43	3.9 ± 0.21	0.19 ± 0.000	0.96 ± 0.041	104.1
	2 Oct	14.1 ± 0.15	2.6 ± 0.25	27.5 ± 1.86	3.6 ± 0.19	0.18 ± 0.014	0.76 ± 0.11	129.4
	28 Oct	7.9 ± 0.58	3.4 ± 0.96	32.7 ± 2.03	4.2 ± 0.21	0.10 ± 0.005	1.2 ± 0.054	63.9
Sierra gooseberry (Ribes Roezlii)	24 Jul	18.1 ± 0.67	1.2 ± 0.18	16.0 ± 1.49	7.2 ± 0.47	0.33 ± 0.014	1.3 ± 0.054	128.3
	7 Aug	18.7 ± 0.83	1.9 ± 0.35	19.2 ± 4.75	8.0 ± 0.26	0.32 ± 0.015	1.1 ± 0.000	244.8
	21 Aug	15.1 ± 1.20	1.9 ± 0.16	11.7 ± 0.47	5.2 ± 0.53	0.25 ± 0.005	0.93 ± 0.041	114.3
	4 Sept	18.3 ± 1.86	1.7 ± 0.16	13.1 ± 0.76	6.8 ± 0.56	0.22 ± 0.017	0.97 ± 0.089	267.6
	18 Sept	15.0 ± 0.41	3.6 ± 0.15	13.8 ± 0.90	5.5 ± 0.27	0.24 ± 0.004	1.1 ± 0.11	159.1
	2 Oct	14.8 ± 0.69	3.0 ± 0.35	13.4 ± 0.36	5.3 ± 0.46	0.21 ± 0.011	1.0 ± 0.089	218.5
	28 Oct	13.9 ± 0.29	3.2 ± 0.53	12.3 ± 0.81	6.3 ± 0.13	0.19 ± 0.007	1.6 ± 0.054	111.0
Snowberry (Symphoricarpos acutus)	24 Jul	13.5 ± 3.23	2.7 ± 0.33	21.4 ± 2.90	6.1 ± 0.36	0.23 ± 0.020	0.84 ± 0.15	192.7
	7 Aug	16.4 ± 0.88	3.5 ± 0.92	29.3 ± 1.80	6.6 ± 0.16	0.20 ± 0.004	0.85 ± 0.032	190.7
	21 Aug	13.0 ± 2.15	5.0 ± 0.11	20.2 ± 0.42	6.8 ± 0.10	0.17 ± 0.004	1.4 ± 0.044	170.3
	4 Sept	12.1 ± 3.41	4.6 ± 0.16	21.1 ± 0.52	7.6 ± 0.19	0.22 ± 0.015	1.4 ± 0.054	114.3
	18 Sept	11.1 ± 0.34	5.8 ± 0.29	20.9 ± 0.32	7.3 ± 0.54	0.18 ± 0.022	1.4 ± 0.089	115.5
	2 Oct	9.3 ± 0.27	7.4 ± 0.41	22.8 ± 1.38	7.3 ± 0.22	0.24 ± 0.020	1.5 ± 0.000	123.2

Fig. 13. Crude protein content of browse species important in the diets of tractable deer on Brush Slope 1, Sierra National Forest.


Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas
PERCENT
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
24 July
7 Aug
21 Aug
4 Sept
18 Sept
2 Oct
28 Oct
TIME

part of the season.

Optimum growth for deer is reported with a ration containing 13 to 20 percent crude protein (French et al. 1956, McEwen et al. 1957, Murphy and Coats 1966, and Thompson 1973). Mountain whitethorn, bitter cherry, and Sierra gooseberry met or exceeded these values throughout the study. Snowberry was in the optimum range from 24 July through 21 August. These four species comprised 59.34 percent of the total diet of the yearlings and 62.12 percent of the total diet of the fawns on Brush Slope 1 (tables 5 and 7).

It appears that the crude protein levels of the forages selected by tractable deer are more than adequate to maintain satisfactory growth rates.

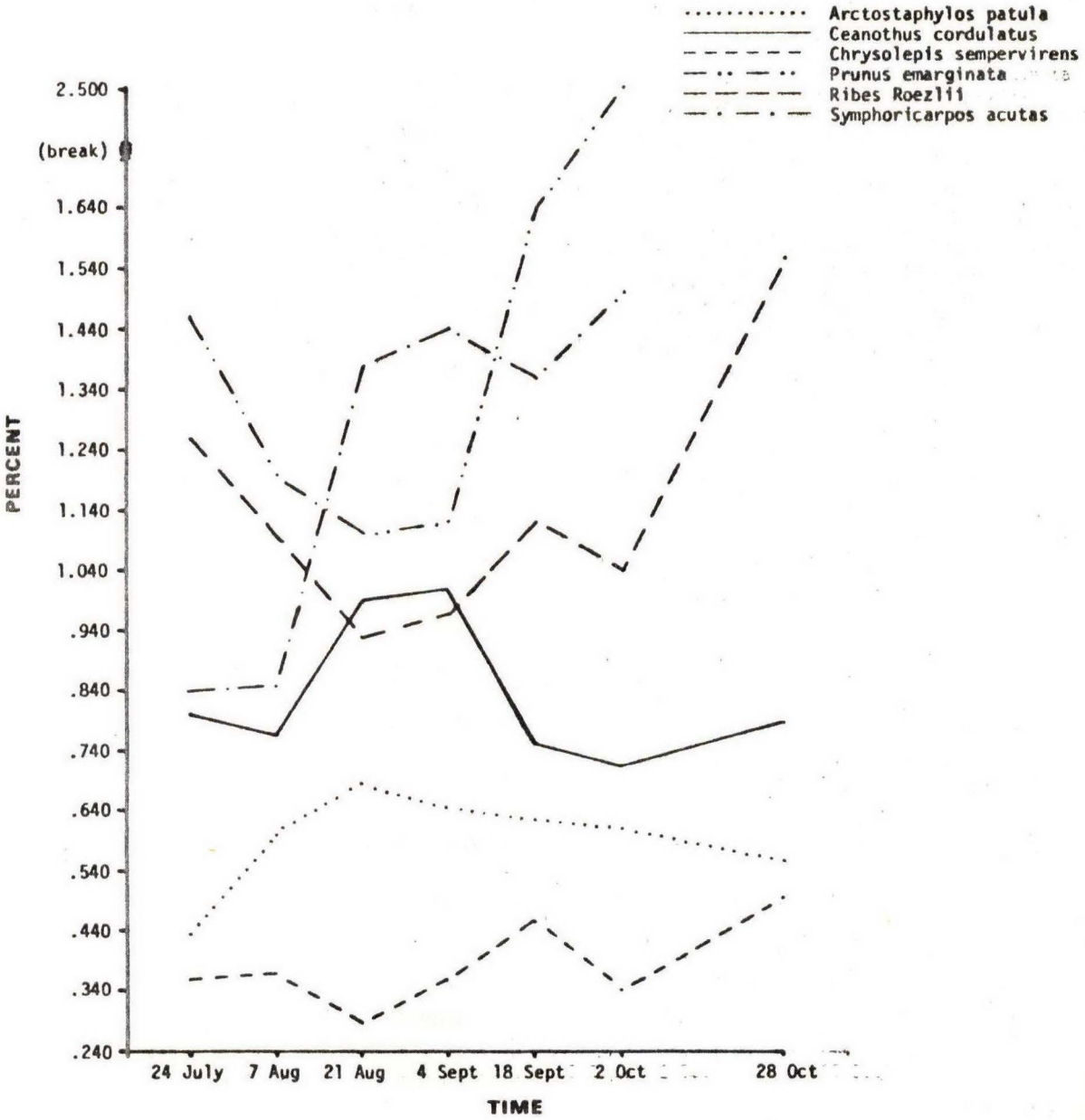
Minerals

Two important minerals in deer diets that may be limiting to growth are calcium and phosphorus (Bissell and Strong 1955, French et al. 1956, Swank 1956, McEwen et al. 1957, and Dietz 1971). Swift (1948) has shown that deer select the available forages containing most calcium and phosphorus.

Calcium

The percent of calcium in the plants sampled ranged from 0.28 percent for chinquapin on 21 August 2.5 percent for bitter cherry on 2 October (Table 14 and Fig. 14). All plants sampled had values exceeding the 0.9 percent reportedly required by white-tailed deer for maintenance (French et al. 1956). McEwen et al. (1957) reported that a calcium content of 0.08 could be tolerated by white-tailed deer if the phosphorus content was at least 0.27 percent of the diet. McEwen et al. (1957) stated that 0.64 percent calcium in the diet produced optimum growth and antler development. Ullrey et al. (1973) consider 0.40 percent dietary calcium in conjunction

Fig. 14. Calcium content of browse species important in the diets of tractable deer on Brush Slope 1, Sierra National Forest.


Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas
2.500
(break)
1.640
1.540
1.440
1.340
1.240
1.140
1.040
.940
.840
.740
.640
.540
.440
.340
.240
PERCENT
24 July
7 Aug
21 Aug
4 Sept
18 Sept
2 Oct
28 Oct
TIME

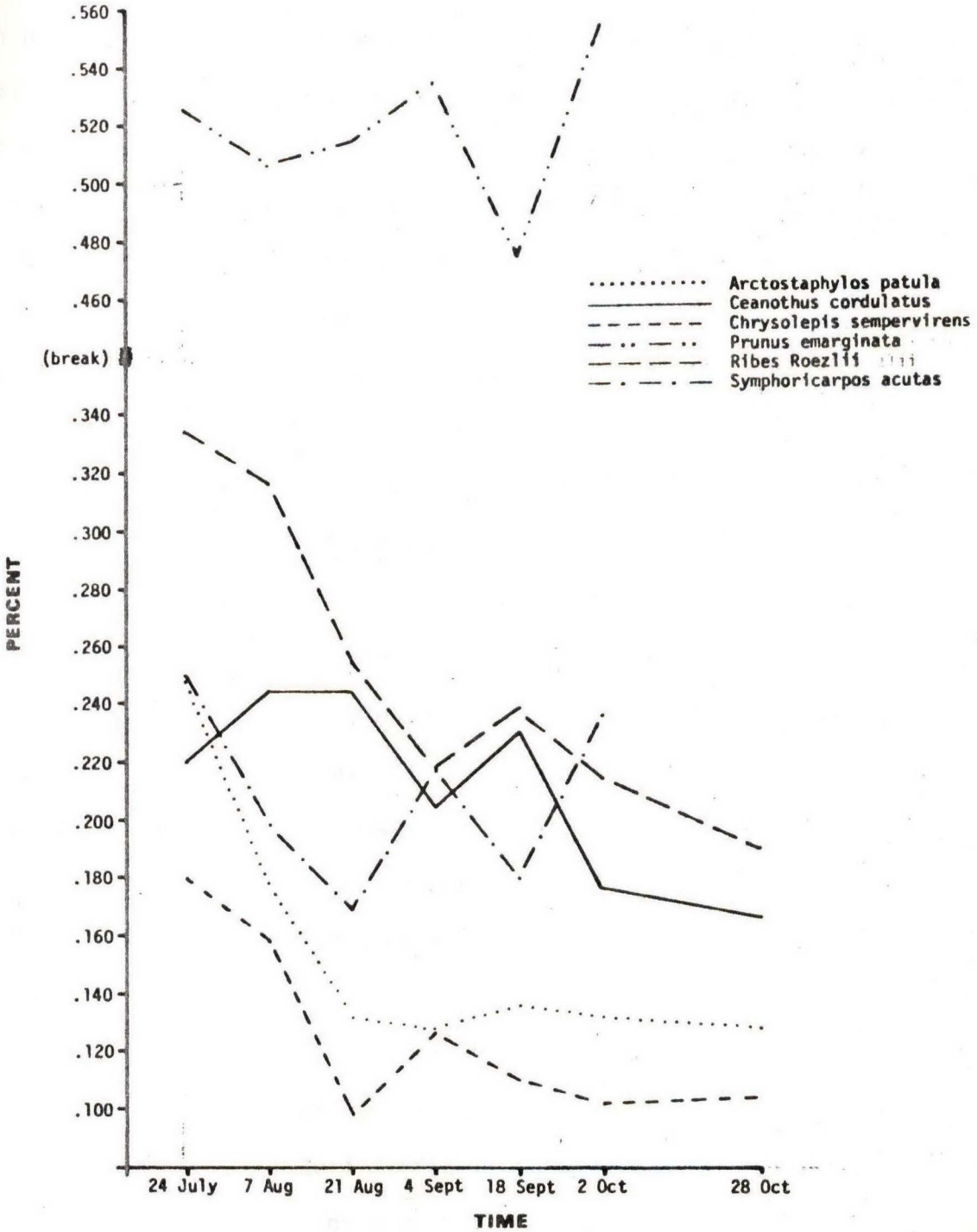
with 0.27 or 0.25 percent dietary phosphorus adequate for normal development of white-tailed deer fawns. He also stated calcium levels of 0.20 percent with phosphorus at 0.27 or 0.25 percent caused many of the parameters being tested to be adversely affected. The National Research Council (1963, 1964) shows minimum calcium requirements to be 0.24 percent for cows and 0.30 percent for ewes which are lactating. All of the samples had calcium percentages exceeding those minimum and optimum values.

Morrison (1957) reported that western ranges of the United States usually had enough calcium in the forage. He also reported the calcium levels may be high enough to adversely affect phosphorus metabolism. Wise et al. (1963) showed the growth of Hereford calves was retarded on calcium levels of 2.43 percent. Only one sample approached this figure in the study. Calcium does not appear to be a problem in the plant species we tested.

Phosphorus

The phosphorus content of the plants sampled ranged from 0.10 percent for chinquapin on 21 August to 0.55 percent for bitter cherry on 2 October (Table 14 and Fig. 15). French et al. (1956) reported that the minimum levels of phosphorus needed for maintenance of white-tailed deer was 0.25 percent with optimum growth achieved on 0.56 percent. McEwen et al. (1957) reported white-tailed deer could survive on a diet containing 0.27 percent phosphorus as long as calcium exceeded 0.08 percent. Ullrey et al. (1975) concluded that weaned white-tailed deer fawns require no more than 0.28 percent phosphorus on a dry weight basis. Pope (1971) found that sheep needed 0.16 to 0.37 percent dry matter of phosphorus. The National Research Council (1963, 1964) reported minimum requirements to be 0.18 percent for

Fig. 15. Phosphorus content of browse species important in the diets of tractable deer on Brush Slope 1, Sierra National Forest.


.560
.540
.520
.500
.480
.460
(break)
.340
.320
.300
.280
.260
.240
.220
.200
.180
.160
.140
.120
.100
PERCENT
24 July
7 Aug
21 Aug
4 Sept
18 Sept
2 Oct
28 Oct
TIME
Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas

cows and 0.22 percent for ewes which are lactating.

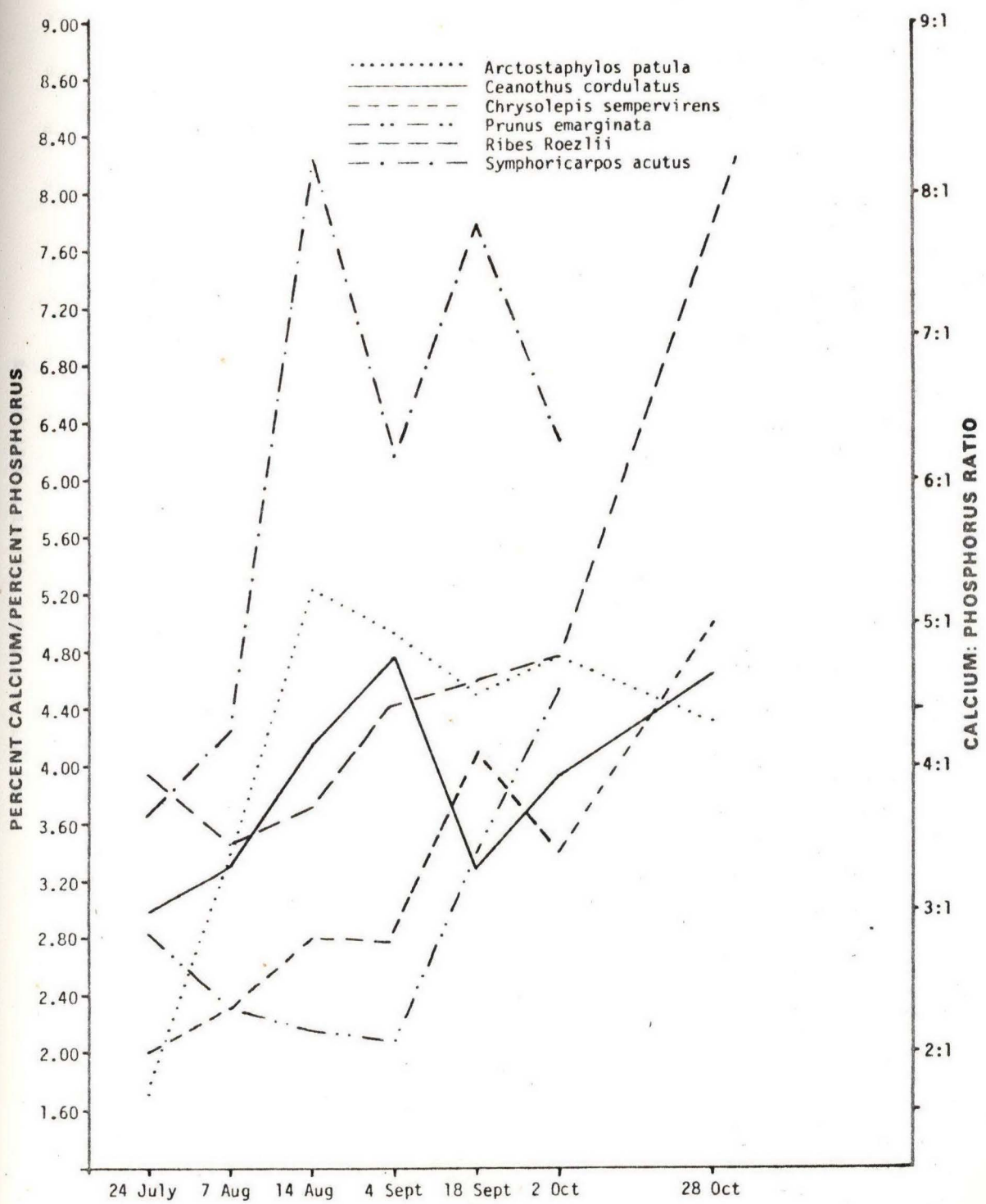
Bitter cherry is the only species to exceed the minimum requirements of French et al. (1956) and McEwen et al. (1957). Their minimum is close to the maximum needed as reported by Ullrey et al. (1975) who also states that further work needs to establish a minimum. In general, the rest of the plants fall within a range of 0.20 to 0.24 percent for the entire season. This falls within the limits of Pope (1971) for sheep. Blood work by Holl (Personal communication) on the North Kings summer range indicates adequate phosphorus levels. No plant ever achieved the optimum level reported by French et al. (1956).

Calcium: Phosphorus ratio

Bissell and Strong (1955) suggest that the calcium to phosphorus ratio could be a limiting factor in deer nutrition. Maynard and Loosli (1956) reported that the desirable calcium to phosphorus ratio for ruminants is between 1 to 2 and 2 to 1. They also reported that this ratio could be wider if enough vitamin D was available in the diet. Wise et al. (1963) reported that Hereford calves grew well on calcium to phosphorus ratios of 1 to 1 to 7 to 1. He also reports that ratios of 0.4 to 1, 0.8 to 1, and 14.3 to 1 cause a depression of growth. Ullrey et al. (1973) reports that calcium to phosphorus ratios of less than 1 to 1 adversely affected a number of parameters while ratios of up to their highest tested (2.4 to 1) do not have deleterious effects on white-tailed deer fawns. Smith et al. (1956) reported that deer suffered no ill effects on a calcium to phosphorus ratio which exceeded 13 to 1 for 9 months of the year.

Calcium to phosphorus ratios of the plants sampled ranged from 1.75 to 1 for greenleaf manzanita on 24 July to 8.5 to 1 for snowberry on 14 August (Fig. 16). Even those these ratios do not fall within the optimum levels,

Fig. 16. Calcium to Phosphorus ratios of browse species important in the diets of the tractable deer on Brush Slope 1, Sierra National Forest.


Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutus
PERCENT CALCIUM/PERCENT PHOSPHORUS
CALCIUM: PHOSPHORUS RATIO
9.00
8.60
8.40
8.00
7.60
7.20
6.80
6.40
6.00
5.60
5.20
4.80
4.40
4.00
3.60
3.20
2.80
2.40
2.00
1.60
9:1
8:1
7:1
6:1
5:1
4:1
3:1
2:1
24 July
7 Aug
14 Aug
4 Sept
18 Sept
2 Oct
28 Oct

they seem to be within acceptable ranges. The ratios are much lower than those reported by Smith et al. (1956) and Snyder (1961) for plants during the growing season.

Fat

Many diverse statements have been made concerning the role of fat in rumen digestion. Dietz (1962) stated although ruminents are not dependent on fats, range animals do well on shrubs containing relatively high proportions of fat. Bissell and Strong (1955) stated that plants eaten by deer are often low in fat and fat in ruminant nutrition appears to be of little importance. Nagy et al. (1964) felt that fat, when measured by the ether extract method, is not a good indicator of the nutritional fat of plants. The ether extract method includes turpines, resins, and essential oils which are not digestable and even may inhibit the rumen function. Smith (1952) indicated that limited protein and high fat made a poor diet for young deer. Dietz (1971) stated that fats in the diet are of little significance in ruminant nutrition. He also stated that fat synthesized in the rumen from proteins and carbohydrates is an excellent form of storage since fat contains approximately twice as many calories per gm as does protein or carbohydrates. Swift (1948) felt that fat levels may be an important factor in browse selection by deer.

The crude fat content of the plants we sampled ranged from 1.5 percent for black oak on 21 August to 7.9 percent for greenleaf manzanita on 28 October (Table 14). In general, the crude fat content of the plants we sampled increased through the season.

Hagen (1953) reported the crude fat content for greenleaf manzanita, bitter cherry, and mountain whitethorn. The crude fat values for the plants we sampled were lower than those reported by Hagen (1953). Our snowberry is

about 25 percent less, bitter cherry is about 40 percent less, and greenleaf manzanita is about 70 percent less for comparable sampling periods.

Fiber

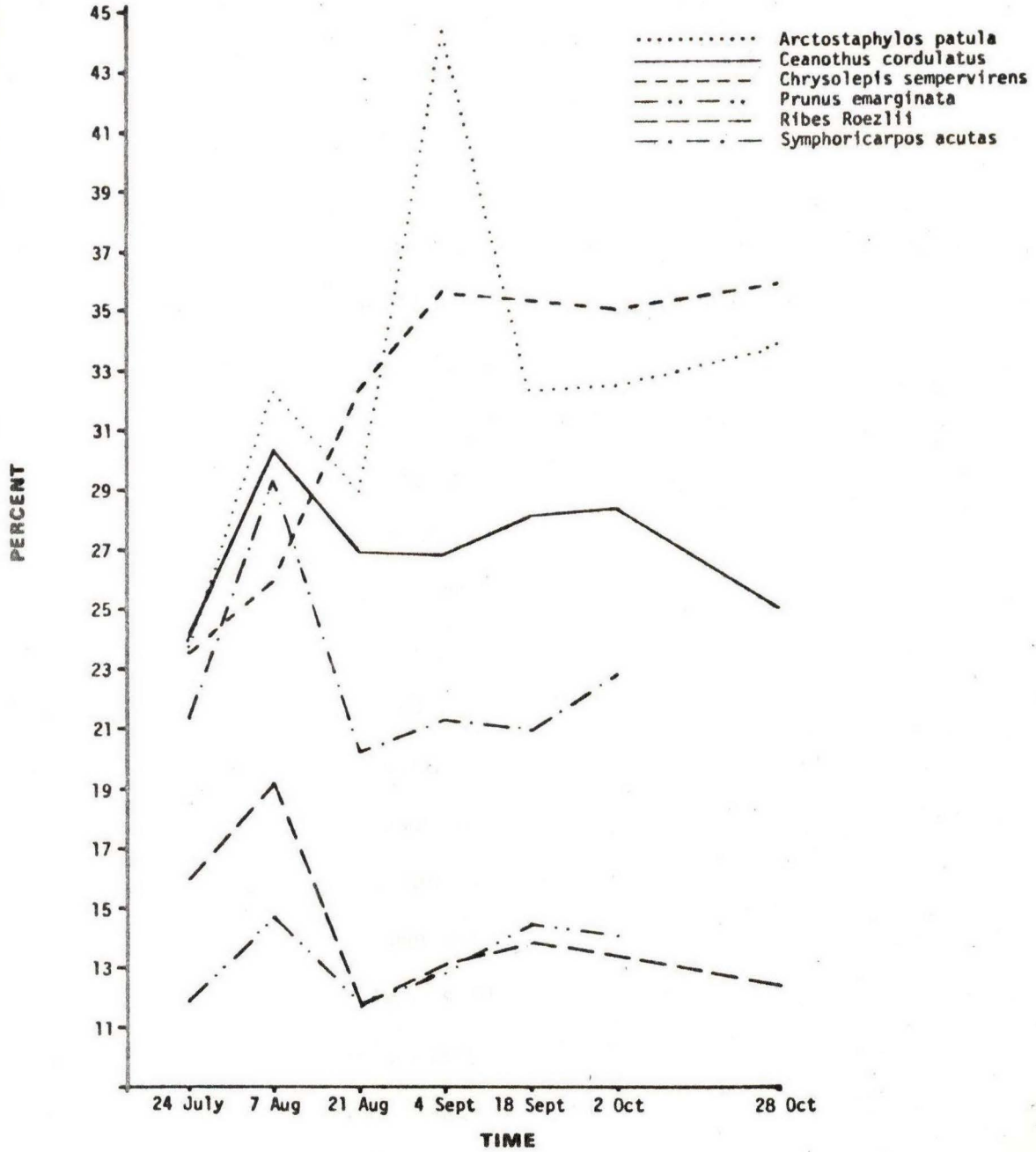
Nutritional content is only part of assessing the acceptability of forages for deer diets (Bissell and Strong 1955). Digestibility must be considered because it influences the usable portion of dietary nutrients. Short (1966) stated available energy is inversely related to the cellulose content as it affects digestion.

Lignin is a barrier to rumen microorganisms attempting to digest the cell wall and its intercellular constituents (Dietz 1971). Van Soest (1967) developed a comprehensive feed analysis system that uses the solubility of cell contents and cell wall components in neutral and acid detergents. The proteins, sugars, and starches of the cell are soluable in acid detergent, while cellulose and lignin are insoluable in it. The residue is measured as acid detergent fiber (ADF) and gives an indication of forage digestability (Van Soest 1967).

ADF is low in the spring and early summer and increases through the growing season so it varies inversely with crude protein values (Dietz 1971). Crude fiber follows the same trend and is reported by Reynolds and Sampson (1943), Hill (1946), Spinner and Bishop (1950), Smith (1952), Bissell and Strong (1955), Morrison (1957), Snyder (1961), Sullivan (1962), Anderson et al. (1965). Smith (1952) pointed out that digestibility varied with species as do the nutrients.

ADF content of the plants we sampled ranged from 11.7 percent for Sierra gooseberry on 21 August to 44.3 percent for greenleaf manzanita on 4 September (Table 14, Fig. 17). ADF values remained relatively constant

Fig. 17. Acid detergent fiber (ADF) content of browse species important in the diets of tractable deer on Brush Slope 1, Sierra National Forest.


Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas
PERCENT
45
43
41
39
37
35
33
31
29
27
25
23
21
19
17
15
13
11
24 July
7 Aug
21 Aug
4 Sept
18 Sept
2 Oct
28 Oct
TIME

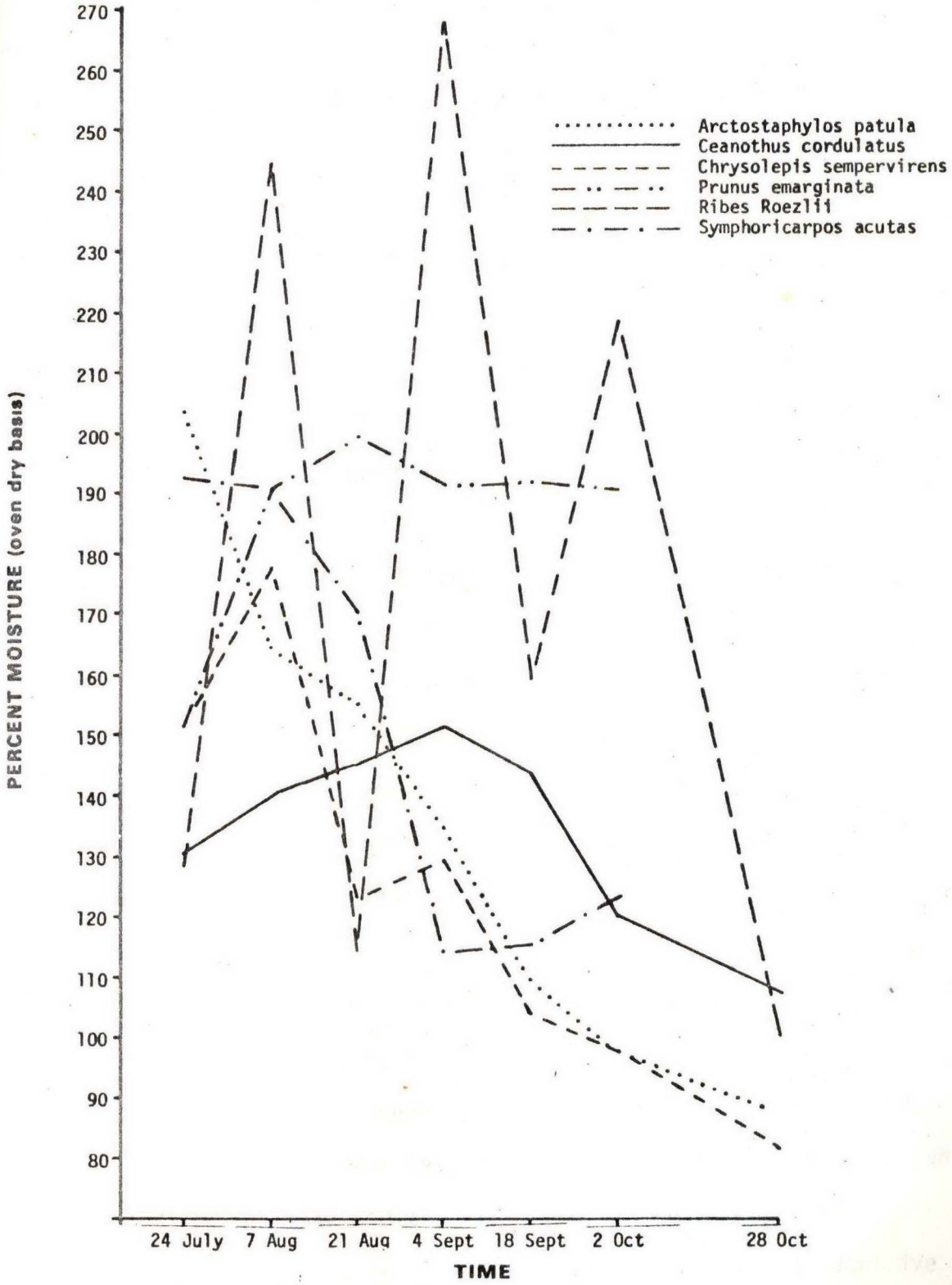
throughout the sampling, with only greenleaf manzanita and chinquapin varying more than 3 percent. All species showed a large increase in ADF for the sampling period of 7 August, then decreased in the next sampling period. Sierra gooseberry, bitter cherry, and snowberry, deciduous species, have a lower ADF content that the evergreen species, and therefore should be more digestible than the evergreen species (Fig. 17).

Moisture

Morrison (1957) stated that water is the most limiting factor in animal nutrition. Reynolds and Sampson (1943) showed that deer used areas where the percent moisture content of plants was relatively high. They also found most plants with consistantly high moisture content were continually used by wild deer. They also reported that seldom used species had considerable use by deer during periods when these plants had a high moisture content. However, they also showed some species, such as manzanita, were always high in moisture content but were little used by deer. Hagen (1953) reported that deer did not like dry food. Bissell and Strong (1955) found that percent moisture content of the plant controlled the amount of protein per gm of forage consumed. A deer would have to consume twice as much of a plant containing 180 percent moisture than it would of a plant containing 90 percent moisture to obtain the same amount of crude protein. Reynolds and Sampson (1943) found that high levels of organic and inorganic constituents were associated with high water content of plants.

The percent moisture in the plants we sampled generally decreased through the growing season (Table 14 and Fig. 18). Percent moisture varied from 63.9 percent for black oak on 28 October to 267.6 percent for Sierra gooseberry on 4 September. Sierra gooseberry had a lower moisture content

Fig. 18. Oven dry moisture content of browse species important in the diets of tractable deer on Brush Slope 1, Sierra National Forest.


270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
PERCENT MOISTURE (oven dry basis)
Arctostaphylos patula
Ceanothus cordulatus
Chrysolepis sempervirens
Prunus emarginata
Ribes Roezlii
Symphoricarpos acutas
24 July
7 Aug
21 Aug
4 Sept
18 Sept
2 Oct
28 Oct
TIME

at the end of the sampling than at the beginning, but was the most variable species and fluctuated widely during the sampling periods. Helmers (1940) also found that moisture was the most variable nutritional parameter that he studied. He reported that most species tended to decrease in moisture content through the growing season. Bitter cherry was the only species that increased in moisture content as the season progressed. These irregular fluctuations may be due to climatic factors such as precipitation and temperature which along with plant properties partially control evapotranspiration rates.

Season of growth appears to be the greatest influence on the nutritional values of forages. Many workers agree that nutrient values are usually highest during the earliest stages of the growing season and decline until the dormant season (Helmers 1940, Reynolds and Sampson 1943, Aldous 1945, Einarsen 1946, Hagen 1953, Bissell and Strong 1955, Smith et al. 1956, Dietz 1958, 1971, Snyder 1961). The plant species we sampled follow the same general trend. Helmers (1940) stated that although the nutrient content of plants follows a seasonal trend, the monthly changes in nutritional parameters do not always parallel each other in either intensity or direction. The plant species we sampled are not consistent in directions and or magnitude of changes throughout the season.

Lay (1956) reported that the nutritive values of deciduous plants changed more through the growing season than did the nutritive value of the evergreen species. Sierra gooseberry, black oak, hazlenut, snowberry, and bitter cherry are deciduous species and tended to exhibit more variation through the growing season than did the evergreen species (Table 14).

The portion of the plant eaten by deer has a large effect on nutritive

quality. Reynolds and Sampson (1943), Aldous (1945), Spinner and Bishop (1950), Cook (1956), Snyder (1961), Dietz (1965, 1971) have shown that different parts of the same plant have different nutrient values. In general, new leaves and leader growth are higher in nutrient quality than are old leaves and stems.

The age of the plant has an affect on the nutritive value of the forage. The nutritional value of the plant changes conspicuously from youth through maturity (Hart et al. 1932, Gordon and Sampson 1932, Helmers 1940).

Deer usage also affects the nutritive value of plants (Smith 1952). He reported that browsing of sprouts produced two results that affect nutritive quality of forage. With a moderate amount of browsing, the nutritional quality of the forage can be improved and the growing period lengthened. However, he also indicated that these desired effects are not obtained if browsing pressure is too intense.

If the nutritional values of the plants we sampled are representative of the summer range of the North Kings deer herd, then we do not expect deer to encounter any qualitative nutritional problems on the summer range. The values for crude protein content of the important species eaten by the tractable deer are near the level reportedly required by deer for optimum growth. The calcium content of the species we studied is within the range reported by earlier workers to be needed by deer for optimum growth. Phosphorus content of the plants sampled was below minimum dietary levels reportedly required by deer. However, Ullrey et al. (1975) states further studies are needed for determining minimum phosphorus dietary requirements. The calcium to phosphorus ratio does not fall within the ratio reported by Maynard and Loosli (1956), but the values are within the ranges reported by other workers as being tolerated by deer.

A more thorough and detailed study of forage availability, quality, and productivity is needed before any valid assessment of the nutritional quality of the summer range of the North Kings deer herd can be made.

RANGE VEGETATION SURVEY

The study site for vegetation sampling was located in the western portion of the North Kings deer herd range. It occupied about 100 km^2 (Fig. 2). The area was both geographically and vegetatively diverse, and ranged in altitude from 1340m to 2610m. Its topography varied from level meadows to steep, 40 degree slopes. The yellow pine forest, red fir forest, and lodgepole pine forest were the three identifiable vegetation types (Munz 1959).

The point-quarter method was used to determine importance values for tree species on each sampling line. Measurements from all lines were combined to obtain importance values for the entire area (Table 15).

The importance values for each line were used to stratify the area into vegetation types. The indicator tree species for the forest communities were yellow pines (Pinus Jeffreyi and P. ponderosa), red fir (Abies magnifica), and lodgepole pine (Pinus Murrayana). These species and white fir (Abies concolor) accounted for 81.9 percent of the trees sampled. These species of trees are relatively equal in their frequency of occurrence (Table 15).

Vegetative cover for the entire area, as measured by the line intercept sampling, was estimated to be 23.79 percent. Sixty-five species of vascular plants including 8 species of trees, 19 species of shrubs, and 38 species of herbaceous plants were encountered by the intercept (Appendix 6). Species which comprised more than 1.0 percent of the cover for the entire area were: greenleaf manzanita, 6.11 percent; chinquapin, 2.73 percent; mountain whitethorn, 2.52 percent; pinemat manzanita (Arctostaphylos nevadensis), 2.07 percent; huckleberry oak (Quercus vaccinifolia), 1.79; red fir, 1.22 percent; and white fir, 1.21 percent.

No one herbaceous species made up more than 1.0 percent of the total

TABLE 15

Point Quarter Sampling for Range Vegetation
Survey Dinkey Subunit, North Kings Deer
Herd, Sierra National Forest

Species	n	Importance Value	Absolute Density	Absolute Dominance	Basal Area per HA
Lodgepole pine (Pinus Murrayana)	338	48.88	24.45	3.28	3.279
Yellow pine (Pinus Jeffreyi) (Pinus ponderosa)	325	68.92	23.51	7.87	7.870
White fir (Abies concolor)	315	55.41	22.78	3.98	3.983
Red fir (Abies magnifica)	287	59.88	20.76	7.25	7.255
Sugar pine (Pinus lambertiana)	164	39.58	11.86	4.51	4.507
Incense cedar (Libocedrus decurrens)	85	15.51	6.15	1.05	1.046
Black oak (Quercus Kelloggii)	38	7.27	2.75	0.37	0.371
Western white pine (Pinus monticola)	19	4.31	1.37	0.40	0.397
Aspen (Populus tremuloides)	1	0.23	0.07	0.01	0.009
TOTAL	1572	300.00	113.70	28.72	28.717

cover. One herbaceous species of which the tractable deer ate a great deal was bracken fern. It comprised 0.75 percent of the vegetative cover. However, actual cover of bracken fern is difficult to assess. Early in the growing season there is little or no bracken fern but it emerges about mid summer in moister places. Vegetation sampling began before the emergence of the bracken fern. This caused its percent of cover to be low for the time of deer use.

Other forbs sampled with the line intercept were found in moist areas such as in meadows and along stream banks. When forbs were sampled in moist areas they were usually very abundant. The most extreme example encountered was a meadow that was about 35m wide and composed of a solid mat of violet (Viola Mackloskeyi). This one line accounted for well over 90 percent of the cover obtained for this species.

Twenty-five samples were taken in the yellow pine stratum and they accounted for 80.6 percent of the total cover of the entire area. Cover in the yellow pine stratum was 30.68 percent. The sample with the greatest amount of cover originated from the middle of the west side of section 35 and had a bearing of 278 degrees true. Vegetative cover on this line was 44,962cm of 89.9 percent. The sample with the least vegetative cover originated from the southeast corner of section 31 and had a bearing of 168 degrees true.

All eight tree species, 18 of the 19 shrub species, and 34 of the forb species were measured in this strata. The species that exceeded 1.0 percent cover in the yellow pine stratum were: greenleaf manzanita, 9.65 percent; mountain whitethorn, 4.03 percent; chinquapin, 3.60 percent; huckleberry oak, 2.83; pinemat manzanita, 1.79 percent; and white fir, 1.69 percent (Table 16).

TABLE 16

Vegetative cover of the Yellow Pine Stratum of Range Vegetation Survey, Dinkey Subunit, North Kings Deer Herd, Sierra National Forest

Species	Total Cover (cm)	Mean ± SD	Percent Cover
Greenleaf manzanita (Arctostaphylos patula)	120,585	4,823.40 ± 1.92E 4	9.65
Mountain whitethorn (Ceanothus cordulatus)	50,326	2,014.48 ± 8.05E 3	4.03
Chinquapin (Chrysolepis sempervirens)	44,940	1,797.60 ± 7.19E 3	3.60
Huckleberry Oak (Quercus vaccinifolia)	35,321	1,412.85 ± 5.46E 3	2.83
Pinemat manzanita (Arctostaphylos nevadensis)	22,323	892.92 ± 3.57E 3	1.79
White fir (Abies concolor)	21,121	844.84 ± 3.38E 3	1.69
Sierra gooseberry (Ribes Roezlii)	8,896	355.84 ± 1.40E 2	0.71
Black oak (Quercus Kelloggii)	3,939	157.56 ± 6.29E 2	0.32
Bitter cherry (Prunus emarginata)	3,764	150.56 ± 6.01E 2	0.30
Snowberry (Symphoricarpus acutus)	3,112	124.48 ± 4.93E 2	0.25
Hazelnut (Corylus cornuta)	1,222	48.88 ± 1.95E 2	0.10
Others	67,889		5.41
TOTAL	383,438		30.68

Seven lines were located in the red fir stratum and accounted for 52,348cm of cover or 14.96 percent cover. The red fir stratum comprised 11 percent of the total cover. The line with the greatest amount of intercept originated from the southwest corner of section 24 at a bearing of 172 degrees true. This line intercepted 26,304cm of cover which is 52.61 percent cover. The sample with the least amount of cover originated from the center of section 21 with a bearing 229 degrees true. This sample intercepted 1500cm of vegetation of 3.00 percent cover.

Species comprising more than one percent of the cover in the red fir stratum were pinemat manzanita, 3.32 percent; red fir, 2.93 percent; and chinquapin, 2.71 percent (Table 17).

Six tree species, 11 shrub species, and 13 forb species were measured by line intercept in the red fir stratum.

Eight lines fell in the lodgepole stratum. These lines were comprised of 9.98 percent cover for the stratum or 9.40 percent cover of the entire area. The sample with the most cover originated from the middle of the west side of section 29 and had a bearing of 270 degrees true. Cover was 8,829cm or 17.66 percent cover. The sample with the least amount of cover started from the center of section 30 with a bearing of 10 degrees true. Four tree species, 6 shrub species, and 17 forb species were sampled in this stratum. Red fir, 2.96 percent; lodgepole pine, 2.61 percent; and pinemat manzanita, 1.85 percent were the only species to exceed 1.0 percent cover in this stratum.

An overview of the three vegetation types reveals that intergradations are common in the ecotonal areas. Generally, lodgepole pine forests and red fir forests are found at higher elevations with yellow pine forests at lower

TABLE 17

Vegetative cover of the Red Fir Stratum of Range Vegetation Survey, Dinkey Subunit, North Kings Deer Herd, Sierra National Forest

Species	Total Cover (cm)	Mean ± SD	Percent Cover
Pinemat manzanita (Arctostaphylos nevadensis)	11,622	1,660.29 ± 1.85E 3	3.32
Red fir (Abies magnifica)	10,249	1,464.14 ± 1.64E 2	2.93
Chinquapin (Chrysolepis sempervirens)	9,497	1,356.71 ± 1.05E 3	2.71
Hazelnut (Corylus cornuta)	1,875	267.86 ± 2.96E 2	0.54
Greenleaf manzanita (Arctostaphylos patula)	1,626	232.29 ± 2.59E 2	0.46
Sierra gooseberry (Ribes Roezlii)	761	108.71 ± 1.21E 2	0.22
Black oak (Quercus Kelloggii)	397	56.71 ± 6.28E 1	0.11
Snowberry (Symphoricarpos acutus)	79	11.29 ± 1.25E 1	0.02
Mountain whitethorn (Ceanothus cordulatus)	42	6.00 ± 6.69E 0	0.01
Bitter cherry (Prunus emarginata)	--		
Others	16,200		4.64
TOTAL	52,348		14.96

elevations. Red fir may occur at lower elevations along drainages when moisture conditions are favorable for it.

Different species were associated with each forest type (Munz 1959). An elevation increased, the amount of cover and number of vascular plant species decreased. Yellow pines red fir, lodgepole pine, and white fir were the only trees present in all three forest types. Pinemat manzanita, greenleaf manzanita, chinquapin, Sierra gooseberry, and sticky current (Ribes viscosissimum) were the only shrub species in all three communities. Pinemat manzanita was the only species to exceed 1.0 percent cover in all three strata.

It appears yellow pine forest with 30.68 percent cover would be the desirable stratum for a foraging deer. This is more cover than in the other two strata combined. Plant species preferred by the tractable deer are more abundant in the yellow pine forest than the other two forest types. In fact, many preferred species do not occur in the red fir and lodgepole pine forests.

The line intercept data does not always reflect availability, therefore qualitative conditions, of vegetation for deer. One sample with 89.9 percent cover, had less browse available to deer than some samples with 10 to 15 percent cover. The sample with 89.9 percent cover had a solid, 100 x 300m patch of mountain whitethorn and chinquapin. Because of its density only the perimeter was available to foraging deer. Most of the plants in this area were old, therefore probably relatively low in nutritional quality (Gordon and Sampson 1939). During the study, many areas of dense brush were observed. Most were not as dense as the previous example but still not present a problem in assessing range quality and condition.

There are other areas with a great deal of cover that may not be good deer habitat. Mature forest stands have a moderate amount of cover. Most cover comes from tree seedlings. There are few shrubs in these areas due to shading of the trees. With limited shrubs cover the preferred species are either limited or absent.

To correctly assess the amount of forage that deer are able to use one would have to consider the plants available to deer, which plant parts deer select, and production of these plant parts. This can be accomplished for each species by measuring the productivity of plant parts utilized by deer. This could then be converted to the percentage of the plant measured by the intercept. The percentage times total cover could then be converted to usable forage for the area. Considering deer requirements one would then be able to assess the quantative condition of the range. Optimum population levels for deer could then be determined for the area.

TABLE 18

Vegetative cover of the Lodgepole Pine Stratum of Range Vegetation Survey, Dinkey Subunit, North Kings Deer Herd, Sierra National Forest

Species	Total Cover (cm)	Mean ± SD	Percent Cover
Red fir (Abies magnifica)	10,777	1,347.13 ± 1.72E 3	2.69
Lodgepole pine (Pinus Murrayana)	10,448	1,306.00 ± 1.67E 3	2.61
Pinemat manzanita (Arctostaphylos nevadensis)	7,418	927.25 ± 1.18E 3	1.85
Sierra Gooseberry (Ribes Roezlii)	887	110.88 ± 1.40E 2	0.22
Chinquapin (Chrysolepis sempervirens)	122	15.25 ± 1.93E 1	0.03
Greenleaf manzanita (Arctostaphylos patula)	82	10.25 ± 1.30E 1	0.02
Hazelnut (Corylus cornuta)	--		
Bitter cherry (Prunus emarginata)	--		
Snowberry (Symphoricarpos acutus)	--		
Mountain whitethorn (Ceanothus cordulatus)	--		
Others	10,192		2.56
TOTAL	39,926		9.98

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APPENDIX I

Species List for Markwood Meadow in the Sierra National Forest scientific names of plants follow Munz (1959, 1968)

Abies concolor (Gord. and Glend.) Lindl.

Achillea lanulosa Nutt.

Agoseris aurantiaca (Hook.) Greene.

Agrostis idahoensis Nash.

Agrostis scabra Willd.

Agrostis stolonifera L. var. major (Gaud.) Farwell.

Allophyllum integrifolium (Brand) A. and V. Grant.

Amelanchier pallida Greene.

Anaphalis margaritacea (L.) Benth. ex Clarke.

Antennaria rosea Greene.

Aquilegia formosa Fisch. in DC.

Arabis glabra (L.) Bernh.

Arnica Chamissonis Less. ssp. foliosa (Nutt.) Maguire.

Aster foliaceous Lindl. var. Parryi (D.C. Eat.) Gray.

Barbarea orthoceras Ledeb.

Bromus tectorum L.

Calocedrus decurrens (Torr.) Florin.

Calochortus minimus Ownbey.

Calyptridium umbellatum (Torr.) Greene.

Camassia Leichtlinii (Baker.) Wats. ssp. Suksdorfi (Greene.) Gould.

Capsella Bursa-pastoris (L.) Medic.

Carex athrostachya Olney.

Carex aurea Nutt.

Carex Bolanderi Olney.

Carex brevipes W. Boott.

Carex fracta Mkze.

Carex heteroneura W. Boott.

Carex Kelloggii W. Boott.

Carex Lemmonii W. Boot.

Carex nebrascensis Dewey.

Carex nervina Bailey.

Carex paucicostata Mkze.

Carex teneraeformis Mkze.

Carex vesicaria L.

Castilleja miniata Dougl. ex Hook.

Ceanothus cordulatus Kell.

Cerastium glomeratum Thuill.

Chenopodium album L.

Cirsium californicum Gray.

Cirsium Andersonii (Gray) Petr.

Collinsia parviflora Dougl. ex Lindl.

Corylus cornuta Marsh. var. californica (A DC.) Sharp.

Cryptantha affinis (Gray) Greene.

Cuscuta sp. (occidentalis Millsp. ?)

Danthonia californica (Trin.) Munro ex Benth.

Deschampsia caespitosa (L.) Beauv.

Deschampsia danthontoides (Trin.) Munro ex Benth.

Descurainia Sophia (L.) Webb.

Dodecatheon Jeffreyi Van Houtte.

Elodea Nuttallii (Planch.) St. John.

Epilobium adenocaulon Hausskn.

Epilobium exaltatum E. Drew.

Epilobium glaberrimum Barb.

Epilobium oregonense Hausskn.

Equisetum arvense L.

Erigeron peregrinus (Pursh) Greene var. angustifolius (Gray) Cronq.

Eriophyllum lanatum (Pursh) Forbes. var. croceum (Greene) Jeps.

Euphorbia serpyllifolia Pers.

Fragaria vesca L. ssp. californica Staudt.

Galium bifolium Wats.

Galium trifidum L. var. subbiflorum Wieg.

Gayophytum diffusum T. and G.

Geranium californicum Jones and Jones

Geum macrophyllum Willd.

Glyceria elata (Nash) Hitchc.

Gnaphalium chilense Spreng.

Gnaphalium palustre Nutt.

Habenaria dilata (Pursh) Hook. var. leucostachys (Lindl.) Ames.

Helenium Bigelovii Gray.

Heleocharis acicularis (L.) R. and S.

Heleocharis palustris (L.) R. and S.

Heleocharis pauciflora (Lightf.) Link

Heracleum lanatum Michx.

Heterocodon rariflorum Nutt.

Hippuris vulgaris L.

Hypericum anagalloides Cham. and Schlecht.

Ivesia unguiculata Gray.

Juncus effusus L. var. pacificus Fern. and Wieg.

Juncus macrandrus Cov.

Juncus megaspermus F. J. Herm.

Juncus nevadensis Wats.

Juncus orthophyllus Cov.

Kelloggia galioides Torr.

Lewisia nevadensis (Gray) Rob. in Gray.

Lilium pardalinum Kell.

Linanthus ciliatus (Benth.) Greene.

Lotus nevadensis Greene.

Lotus oblongifollius (Benth.) Greene.

Lotus Purschianus (Benth.) Clem. and Clem. var. glaber (Nutt.) Munz.

Lupinus polyphyllus Lindl.

Luzula comosa E. Mey.

Mentzelia dispersa Wats.

Microsteris gracilis (Hook.) Greene.

Mimulus guttatus Fisch. ex DC.

Mimulus moschatus Dougl. ex Lindl.

Mimulus primuloides Benth. var. pilosellus (Greene) Smiley.

Mimulus Tilingii Regel.

Monolepis Nuttalliana (Schult.) Greene.

Montia Chamissoi (Ledeb.) Dur. and Jacks.

Montia perfoliata (Donn) Howell var. depressa (Gray) Jeps.

Montia verna Neck.

Muhlenbergia filiformis (Thurb.) Rydb.

Navarretia divaricata (Torr.) Greene.

Nemophila spatulata Cov.

Nicotiana attenuata Torr.

Orthocarpus lacerus Benth.

Osmorhiza chilensis H. and A.

Oxypolis occidentalis Coult. and Rose.

Pedicularis attollens Gray.

Penstemon oreocharis Greene.

Perideridia Gairdneri (H. and A.) Math.

Phacelia mutablis Greene.

Phalacroseris Bolanderi Gray.

Phleum pratense L.

Pinus contorta Dougl. ex Loud.

Pinus Jeffreyi Grev. and Balf. in A. Murr.

Pinus Lambertiana Dougl.

Plagiobothrys bracteatus (Howell) Jtn.

Plagiobothrys hispidulus (Greene) Jtn.

Plagiobothrys Torreyi (Gray) Gray.

Poa annua L.

Poa pratensis L.

Polygonum aviculare L.

Polygonum bistortoides Pursh.

Polygonum Douglasii Greene.

Polygonum Kelloggii Greene.

Populus tremuloides Michx.

Potamogeton alpinus Balbis var. tenuifolius (Raf.) Ogden.

Potamogeton natans L.

Potentilla Drummondii Lehm.

Potentilla glandulosa Lindl. ssp. Hansenii (Greene) Keck.

Potentilla gracilis Dougl. ex Hook. ssp. Nuttallii (Lehm.) Keck.

Prunella vulgaris L. ssp. lanceolata (Barton) Hult.

Psilocarphus tenellus Nutt.

Pteridium aquilinum (L.) Kuhn var. pubescens Underw.

Ranunculus Flammula L. var. ovalis (Biegl.) L. Benson.

Ranunculus orthorhynchus Hook. var. Hallii Jeps.

Ranunculus uncinatus D. Don in G. Don.

Rhododendron occidentale (T. and G.) Gray.

Ribes nevadense Kell.

Ribes Roezlii Regel.

Ribes viscosissimum Pursh.

Rorippa curvisiliqua (Hook.) Bessey.

Rumex angiocarpus Murbeck.

Rumex triangulivalvis (Danser) Rech. f.

Sagina saginoides (L.) Karst. var. hesparia Fern.

Salix lasiolepis Benth.

Salix Scouleriana Barr.

Sambucus caerulea Raf.

Saxifraga oregona Howell.

Scirpus Congdonii Britton.

Scribneria Bolanderi (Thurb.) Hack.

Senecio triangularis Hook.

Sidalcea reptans Greene.

Sisyrinchium bellum Wats.

Solidago canadensis L. ssp. elongata (Nutt.) Keck.

Sparganium angustifolium Michx.

Spergularia rubra (L.) J. and C. Presl.

Spiranthes Romanzoffiana C. and S.

Stachys rigida Nutt. ex Benth. ssp. rivularis (Heller) Epl.

Stellaria Jamesiana Torr.

Stellaria longipes Goldie.

Taraxacum officinale Wiggers.

Thalictrum sparsiflorum Turcz.

Trifolium microcephalum Pursh.

Trifolium monanthum Gray.

Trifolium repens L.

Trifolium variegatum Nutt. in T. and G.

Trifolium Wormskioldii Lehm.

Trillium chloropetalum (Torr.) Howell

Vaccinium occidentale Gray.

Veratrum californicum Durand.

Veronica Anagallis-aquatica L.

Veronica serpyllifolia L. var. humifusa (Dickson) Vahl.

Viola glabella Nutt.

Viola Macloskeyi Lloyd.

APPENDIX II

Species List for Brush Slope 1 in the Sierra National Forest scientific names of plants follow Munz (1959, 1968)

Abies concolor (Gord. and Glend.) Lindl.

Agropyron trichophorum (Link) Richt.

Allium campanulatum Wats.

Allophyllum integrifolium (Brand) A. and V. Grant.

Apocynum pumilum (Gray) Greene.

Arabis platysperma Gray.

Arabis rectissima Greene.

Arabis repanda Wats.

Arctostaphylos patula Greene.

Brodiaea pulchella (Salisb.) Greene.

Bromus Orcuttianus Vasey.

Bromus tectorum L.

Calocedrus decurrens (Torr.) Florin.

Calochortus Leichtlinii Hook. f.

Calyptridium umbellatum (Torr.) Greene

Calystegia malacophylla (Greene) Munz.

Carex fracta Mkze.

Carex multicaulis Bailey.

Chrysolepis sempervirens (Kell.) Dudl.

Castilleja disticha Eastw.

Ceanothus cordulatus Kell.

Chenopodium album L.

Chrysopsis Breweri Gray.

Clarkia rhomboidea Dougl.

Collinsia Torreyi Gray.

Collinsia Torreyi Gray var. Wrightii (Wats.) Jtn.

Corylus cornuta Marsh. var. californica (A DC.) Sharp.

Cryptantha affinis (Gray) Greene.

Cryptantha simulans Greene.

Elymus glaucus Buckl.

Erigeron Breweri Gray.

Eriogonum nudum Dougl. ex Benth.

Erysimum capitatum (Dougl.) Greene.

Galium sparsiflorum Wight.

Gayophytum diffusum T. and G.

Gayophytum eriospermum Cov.

Gayophytum humile Juss.

Gnaphalium chilense Spreng.

Gnaphalium palustre Nutt.

Hackelia mundula (Jeps.) Ferris.

Hieracium albiflorum Hook.

Hieracium horridum Fries.

Horkelia tridentata Torr.

Kelloggii galioides Torr.

Lilium Washingtonianum Kell.

Linanthus ciliatus (Benth.) Greene.

Lotus crassifolius (Benth.) Greene.

Lotus nevadensis Greene.

Lotus Purshianus (Benth.) Clem. and Clem. var. glaber (Nutt.) Munz.

Lupinus latifolius J. G. Agardh.

Melica aristata Thurb. ex Bol.

Mentzelia dispersa Wats.

Mimulus moschatus Dougl. ex Lindl.

Monardella odoratissima Benth. ssp. pallida (Heller) Epl.

Navarretia divaricata (Torr.) Greene.

Pedicularis semibarbata Gray.

Penstemon Newberryi Gray.

Phacelia mutabilis Greene.

Phacelia Quickii J. T. Howell.

Phacelia racemosa (Kell.) Bdg.

Phacelia hydrophylloides Torr. ex Gray.

Pinus Jeffreyi Grey. and Balf. in A. Murr.

Pinus Lambertiana Dougl.

Polygonum aviculare L.

Potentilla glandulosa Lindl. ssp. Hansenii (Greene) Keck.

Pteridium aquilinum (L.) Kuhn var. pubescens Underw.

Quercus Kelloggia Newb.

Rhamnus rubra Greene.

Ribes nevadense Kell.

Ribes Roezlii Regel.

Rosa californica Cham. and Schlecht.

Rubus parviflorus Nutt.

Rumex angiocarpus Murbeck.

Rumex triangulivalvis (Danser) Rech. f.

Salix Scouleriana Barr.

Sambucus caerulea Raf.

Senecio aronicoides DC.

Silene Lemmonii Wats.

Sitanion jubatum J. G. Sm.

Solanum Xantii Gray var. montanum Munz.

Solidago canadensis L. ssp. elongata (Nutt.) Keck.

Spergularia rubra (L.) J. and C. Presl.

Stipa californica Merr. and Davy.

Streptanthus tortuosus Kell.

Symphoricarpos acutus (Gray) Dieck.

Trichostema oblongum Benth.

Trifolium monanthum Gray.

Viola lobata Benth.

Viola purpurea Kell.

APPENDIX III

Plant phenology observations from Markwood Meadow, Sierra National Forest, during summer 1975

Markwood Meadow	19-24 June 1975
Yearling trials S1-8	
Ribes Roezlii	Plants in full bloom.
Juncus macrandrus	Plants starting to bloom.
Carex sp.	Most species in full bloom.
Dodecatheon Jeffreyi	Plants in full bloom. Most inflorescences show deer use.
Potentilla glandulosa	Blooms starting to appear. Plants show deer use on leaves and inflorescences.
Potentilla gracilis	Plants with rosettes of leaves present. Some plants blooming in the drier portions of the meadow. Deer using leaves.
Ivesia unguiculata	Some blooms present in the drier portions of the meadow. Plants show some deer use.
Rumex angiocarpus	Plants in full bloom. Deer using leaves and inflorescences.
Polygonum bistortoides	Leaves very available to deer. Flower heads are up, but not in bloom.
Lupinus polyphyllus	Plants starting to bloom.
Camassia Leitchlinii	Flower buds are almost ready to open. Wild deer are using leaves, but not the inflorescences.
Phalacroseris Bolanderi	Plants have leaves present but no flower buds have developed.
Lotus Purshianus	Plants just coming up.

*32 cows were on the meadow study site from 23-24 June.

Markwood Meadow	26 June-6 July 1975

Yearling trials S9, 11, 12, 15

Ribes Roezlii	Plants with some fruits starting to develop.
Juncus macrandrus	Plants in dry sites have been heavily damaged by frost.
Carex sp.	Flower heads show frost damage.
Dodecatheon Jeffreyi	Inflorescences show frost damage. The fruits are starting to develop on undamaged flowers.
Potentilla glandulosa	Plants in full bloom.
Potentilla gracilis	More plants starting to bloom.
Ivesia unguiculata	Plants show some frost damage to inflorescences.
Rumex angiocarpus	No change in phenology.
Polygonum bistortoides	Plants starting to bloom.
Lupinus polyphyllus	About 50 percent of the plants are in bloom.
Camassia Leitchlinii	Plants starting to bloom.
Phalacroseris Bolanderi	Buds beginning to show.
Lotus Purshianus	Plants about 2.5cm tall with 3-4 leaves out.

*42 cows had access to meadow study site from 26 June-2 July.
34 cows were counted on the meadow site from 3-6 July.

Markwood Meadow	8-6 July 1975

Yearling trials S18-20, 23, and 24

Ribes Roezlii	Plants have finished blooming and fruits are developing. Deer use present on leader growth.
Juncus macrandrus	Plants previously damaged by frost, are coming into bloom again.

Carex sp.	Plants still in full bloom.
Dodecatheon Jeffreyi	Plants in fruit.
Potentilla galndulosa	Plants still blooming heavily and some fruits developing.
Potentilla gracilis	Plants showing heavy cattle use. Most plants are in flower.
Ivesia unguiculata	Plants in full bloom. Leaves and flowers more available to deep than during the last trial period.
Rumex angiocarpus	Plants still blooming. Fruits are developing.
Polygonum bistortoides	Plants in full bloom.
Lupinus polyphyllus	Plants in full bloom. Some fruits are beginning to develop.
Camassia Leitchlinii	Plants in full bloom.
Phalacroseris Bolanderi	Plants starting to bloom.
Lotus Purshianus	Plants up to 8cm tall. Some are starting to bloom.

*A total of 35 cows had access to meadow study area during this trial period. The central, drier portion of the meadow shows heavy cattle grazing and trampling.

Markwood Meadow 29-31 July 1975

Yearlings trials S27, 28, and 31

Ribes Roezlii	No change in phenology or wild deer use.
Juncus macrandrus	Most inflorescences have been eaten by cattle.
Carex sp.	Most of the inflorescences and about one-half the leaves eaten by cattle.
Dodecatheon Jeffreyi	Most plants eaten by cattle.
Potentilla glandulosa	Flowers are decreasing on plants still in flower.

Potentilla gracilis	Plants showing heavy grazing.
Ivesia unguiculata	Many inflorescences have been grazed by cattle.
Rumex angiocarpus	Most plants in full fruit. Plants in drier areas starting to show heavy cattle use.
Polygonum bistortoides	Plants still blooming.
Lupinus polyphyllus	Some inflorescences have mature fruits developing.
Camassia Leitchlinii	Some plants are still in bloom. Fruits are beginning to develop.
Phalacroseris Bolanderi	Plants in full bloom.
Lotus Purshianus	Plants up to 15cm tall are in full bloom, and have a few fruits.

*35 cows had access to the meadow sample site during this trial period.

Markwood Meadow 14-16 August 1975

Yearling trials S32, 35, and 36

Ribes Roezlii	Fruits mature in size and turning reddish.
Juncus macrandrus	Plants grazed heavily by cattle.
Carex sp.	Plants of most species are starting to yellow and dry and are heavily grazed by cattle.
Dodecatheon Jeffreyi	No change in phenology.
Potentilla glandulosa	All portions of plants except the basal rosettes have been eaten. Plants in protected areas have not been eaten by the cattle.
Potentilla gracilis	Most portions of plants eaten except the rosettes.
Ivesia unguiculata	Most inflorescenes have been grazed by cattle. The leaves are still available.
Rumex angiocarpus	Plants drying up or badly trampled except along Markwood Creek and around the bases of stumps in the drier areas.

Polygonum bistortoides	Most flower heads have been eaten by cattle. Leaves are still available although hidden in the Carex leaves.
Lupinus polyphyllus	Plants in full fruit.
Camassia Leitchlinii	No flowers present. Fruits are reaching mature size.
Phalacroseris Bolanderi	Most plants eaten by cattle.
Lotus Purshianus	Plants drying or being trampled in the drier areas.

*21-35 cows were using the meadow during this trial period. Most of the meadow resembles a mowed lawn and even the marshy areas along the south edge of the meadow shows heavy use.

APPENDIX IV

Plant phenology observations from Brush Slope 1, Sierra National Forest, during summer 1975.

Brush Slope 1	30 June-7 July 1975
Yearling trials S10-13, 14, 16, and 17	
Ceanothus cordulatus	Plants are in full bloom with 5-8cm of leader growth out. Recent deer use in evident on leader growth and new leaves.
Chrysolepis sempervirens	2-8cm of leader growth is present. Plants show recent deer use on leader growth.
Prunus emarginatus	Plants past full bloom and have leader growth out to 8cm. Leaders show recent deer use.
Arctostaphylos patula	Most flowers have dropped and fruits are beginning to develop. Small bushes have 2 to 5cm of new growth out. Large, blooming size, bushes having 3cm of new growth out. Plants show deer use on leader growth.
Quercus Kelloggii	Most leaves are mature in size and still have a soft texture. Trees show heavy deer use on lower branches.
Abies concolor	Terminal buds are breaking on most trees.
Symphoricarpos acutus	Plants in full bloom and some leaves are mature. Plants show deer use on leader growth.
Lupinus latifolius	Purple color is developing on inflorescences, but no flowers are open yet.
Bromus Orcuttianus	Plants up to 8cm tall. Plants show some deer use.
Solanum Xantii	Plants starting to bloom. This species shows only minor deer use.
Phacelia mutabilis	Inflorescences have developed, but no flowers are open. Inflorescences show some deer use.
Gayophytum eriospermum	Plants starting to bloom and are about 18 to 20cm inches in height

Brush Slope 1 — 14-19 July 1975

Yearling trials S21, 22, 25, and 26

Ceanothus cordulatus	Most plants are in fruit and some flowers are still present. Leader growth up to 10cm long. Plants show heavy deer use.
Chrysolepis sempervirens	Shrubs with 5 to 13 (18)cm new growth.
Prunus emarginatus	Most plants are past flowering. Leader growth is up to 15cm. Still shows deer use on leader growth.
Arctostaphylos patula	Fruits are more or less full sized but still green, leader growth on non-blooming bushes (small) is up to 6 inches long.
Quercus Kelloggii	No change in phenology or deer use.
Abies concolor	New growth out approximately 1cm.
Symphoricarpos acutus	Leaders still growing, some up to 1 foot in length, some leaves mature.
Lupinus latifolius	Plants starting to bloom.
Bromus Orcuttianus	Flower heads present and some plants are starting to bloom.
Solanum Xantii	Plants are up to 20cm tall and are in full bloom. Plants show little deer use.
Phacelia mutabilis	Inflorescences up to 1 foot tall, no blooms present. Inflorescences show heavy deer use.
Gayophytum eriospermum	Plants are in full bloom, but 1 foot tall.

Brush Slope 1 — 30 July-4 August 1975

Yearling trials S29 and 30
Fawn trials F1-11

Ceanothus cordulatus	Plants are past flower. No other change in phenology or deer use.

Chrysolepis sempervirens	Leader growth becoming tougher and most growth has stopped.
Prunus emarginatus	Leader growth between 30 to 40cm long. Leader growth shows heavy deer use.
Arctostaphylos patula	No change in phenology.
Quercus Kelloggii	Leaves are becoming leathery.
Abies concolor	Trees have about 3cm of new growth out.
Symphoricarpos acutus	Flowers are gone. New growth is about mature size.
Lupinus latifolius	Plants approaching full bloom.
Bromus Orcuttianus	Plants in full bloom.
Solanum Xantii	Few flowers remain and some fruits are almost full sized.
Phacelia mutabilis	Plants are starting to bloom.
Gayophytum eriospermum	Plants still have lots of flowers. Showing heavy deer use.

Brush Slope 1 — 14-21 August 1975

Yearling trials S33, 34, 37-41
Fawn trials F13, 14, 21-23.

Ceanothus cordulatus	Plants have fruits drying and most leaves attaining mature size. Still seeing heavy deer use on leaves and leaders.
Chrysolepis sempervirens	No change in phenology.
Prunus emarginatus	Leaves are beginning to yellow and dry. Still shows heavy deer use which is primarily on leaders and root sprouts.
Arctostaphylos patula	Last years leaves starting to turn yellow and drop.
Quercus Kelloggii	No change in phenology or deer use.

Abies concolor	Trees have about 4cm of new growth out. Needles attaining mature size.
Symphoricarpos acutus	Most leaves are mature and the oldest ones are beginning to drop. New growth is up to 60cm long. Leader growth still shows deer use.
Lupinus latifolius	Plants still blooming heavily and some fruits developing.
Bromus Orcuttianus	Some plants are beginning to dry.
Solanum Xantii	Flowers are gone and some fruits are mature. Plants show some new deer use.
Phacelia mutabilis	Plants still blooming.
Gayophytum eriospermum	Most plants have completed bloom and are approximately 2 feet tall.

Brush Slope 1 — 31 August-3 September 1975

Fawn trials F25, 27, 28, 30-32

Ceanothus cordulatus	Last year's leaves starting to yellow and drop.
Chrysolepis sempervirens	New growth mature.
Prunus emarginatus	Leaves on most bushes are starting to drop.
Arctostaphylos patula	Most of last year's leaves have dropped.
Quercus Kelloggii	Some small trees on the study site are putting out a few new leaves.
Abies concolor	Most new growth mature.
Symphoricarpos acutus	Oldest leaves are dropping and most new growth has stopped.
Lupinus latifolius	Plants still have a few flowers open and some fruits are mature.
Bromus Orcuttianus	Inflorescences are dry and some leaves are starting to dry.

Solanum Xantii	No change in phenology. Plants still show light deer use.
Phacelia mutabilis	Plants in fruit and the leaves are starting to dry.
Gayophytum eriospermum	Plants starting to dry.

Brush Slope 1	18-21 September 1975
Fawn trials F43-50	
Ceanothus cordulatus	Some plants starting a second bloom and all old leaves have dropped.
Chrysolepis sempervirens	No change in phenology.
Prunus emarginatus	Root sprouts are still green and tender. Most other leaves are yellow and dropping.
Arctostaphylos patula	Mature bushes have 2-4 leaves out of the terminal buds.
Quercus Kelloggii	No change in phenology.
Abies concolor	No change in phenology.
Symphoricarpos acutus	All leaves except those on leader growth have dropped from the plants.
Lupinus latifolius	Plants in fruit only.
Bromus Orcuttianus	Only a few green leaves are left.
Solanum Xantii	All fruits are mature.
Phacelia mutabilis	Inflorescences are starting to dry.
Gayophytum eriospermum	Plants are dry.

Brush Slope 1	2-5 October 1975
Fawn trials F51-61	
Ceanothus cordulatus	No change in phenology.
Chrysolepis sempervirens	No change in phenology.
Prunus emarginatus	Most leaves have dropped from the lower portions of bushes.
Arctostaphylos patula	Leaves are mature.
Quercus Kelloggii	Leaves are starting to yellow.
Abies concolor	New needles are becoming tough.
Symphoricarpos acutus	No change in phenology.
Lupinus latifolius	Plants are drying and the fruit pods are dehiscing.
Bromus Orcuttianus	No change in phenology.
Solanum Xantii	No change in phenology.
Phacelia mutabilis	Leaves are beginning to dry.
Gayophytum eriospermum	No change in phenology.

APPENDIX V

Plant phenology observations from the Lupine Area, Sierra National Forest, during summer 1975

Lupine Area	18-20 August 1975
Fawn trials F15-20	
Sambucus caerulea	Plants coming into full bloom. Leaves are mature.
Ceanothus cordulatus	Fruits starting to drop. Plants show wild deer use.
Ceanothus parvifolius	Fruits starting to drop. Plants show deer use on leader growth.
Lupinus latifolius	Plants in flower and some fruits are maturing.
Arctostaphylos patula	Fruits are mature sized, but are not yet ripe.
Corylus cornuta	Leaves are mature. Plants show heavy deer use.
Salix sp.	Plants have up to 15cm of new growth. Plants show heavy wild deer use.
Abies concolor	Up to 5cm of new growth present. Plants showing wild deer use on young needles.
Phacelia mutabilis	Plants are mostly in fruit with a few flowers left. Shows heavy deer use on inflorescences.
Gayophytum eriospermum	Plant in full bloom.
Potentilla glandulosa	Plants mostly in fruit and have only a few flowers left. Plants show deer use on leaves and inflorescences.

Lupine Area	21 August-2 September 1975
Fawn trials F24, 26, and 29	
Sambucus caerulea	Plants still blooming and some fruits are developing.

Ceanothus cordulatus	Previous season's leaves becoming yellow and dropping. Plants still show deer use on leader growth.
Ceanothus parvifolius	Previous season's leaves becoming yellow and dropping.
Lupinus latifolius	Plants have no flowers on them. Some fruits are mature.
Arctostaphylos patula	Previous seasons leaves are becoming yellow and dropping. Fruits are still green.
Corylus cornuta	No change in phenology.
Salix sp.	Plants with up to 20cm of new growth present.
Abies concolor	Needles becoming tough.
Phacelia mutabilis	Plants in fruit and only a few inflorescences are drying.
Gayophytum eriospermum	Most plants have completed blooming and are starting to dry.
Potentilla glandulosa	Most plants are in fruit and some are drying out.

Lupine Area — 11-14 September 1975

Fawn trials F37-42

Sambucus caerulea	Some flowers present, berries maturing but still green. Wild deer use present on leaves and inflorescences with maturing berries.
Ceanothus cordulatus	Some bushes are having a second bloom. Most of the old leaves have dropped.
Ceanothus parvifolius	All of the previous seasons and some of this seasons leaves have dropped.
Lupinus latifolius	Plants with mature fruits and basal leaves beginning to dry.
Arctostaphylos patula	8 to 13cm of new growth mature on most bushes, leaves of previous season have dropped

Corylus cornuta	Oldest leaves beginning to yellow.
Salix sp.	All new growth mature, some older leaves turning yellowish.
Abies concolor	New growth has matured.
Phacelia mutabilis	Inflorescences are drying, most have been eaten by the wild deer.
Gayophytum eriospermum	Most plants are dry.
Potentilla glandulosa	Inflorescences are drying and many have been utilized by deer.

APPENDIX VI

Vegetative cover available to deer as measured by line intercept in a 100 km^2 area of the summer range of the North Kings deer herd, Sierra National Forest

Species	Total Cover (cm)	Mean sd	Percent Cover
TREES			
Abies magnifica	24,319	607.69 3.88E 3	1.22
Abies concolor	24,246	606.15 3.89E 3	1.21
Pinus Murrayana	13,009	325.23 2.08E 3	0.65
Libocedrus decurrens	9,511	237.77 1.52E 3	0.48
Pinus Lambertiana	4,777	119.43 7.63E 2	0.24
Quercus Kelloggii	4,336	108.40 6.93E 2	0.22
Pinus (Yellow)	4,185	104.63 6.69E 2	0.21
Populus tremuloides	536	13.40 8.48E 1	0.03
SHRUB			
Arctostaphylos patula	122,293	3,057.32 1.96E 4	6.11
Chrysolepis sempervirens	54,559	1,363.97 8.73E 3	2.73
Ceanothus cordulatus	50,404	1,260.10 8.06E 3	2.52
Arctostaphylos nevadensis	41,363	1,034.07 6.62E 3	2.07
Quercus vaccinifolia	35,848	896.20 5.73E 3	1.79
Ribes Roezlii	10,544	263.60 1.68E 3	0.53
Salix spp.	6,100	152.50 9.72E 2	0.30
Prunus emarginata	33,764	94.10 6.01E 2	0.19
Chamaebatia foliolosa	33,668	91.70 5.86E 2	0.18
Ribes viscosissimum	3,359	83.92 5.36E 2	0.17

Symphoricarpos acutus	3,191	79.78 5.09E 2	0.16
Corylus cornuta	3,097	77.42 4.93E 2	0.15
Vaccinium occidentale	2,866	71.65 4.53E 2	0.13
Rhododendron occidentale	2,482	62.05 3.96E 2	0.12
Ribes Nevadense	840	21.00 1.34E 2	0.04
Rubus parviflorus	342	8.55 5.45E 1	0.02
Cornus spp.	248	6.20 3.93E 1	0.01
Rhamnus rubra	132	3.30 2.10E 1	0.01
Ceanothus parvifolius	68	1.70 1.08E 1	T
HERBACEOUS			
Pteridium aquilinum	15,037	375.92 2.40E 3	0.75
Potentilla glandulosa	4,361	109.03 6.91E 2	0.22
Viola Macloskeyi	3,754	93.85 5.94E 2	0.19
Phacelia hydrophylloides	2,959	73.79 2.55E 2	0.15
Aster spp.	2,942	73.55 4.62E 2	0.07
Senecio triangularis	2,728	68.20 4.34E 2,	0.14
Lupinus polyphyllus	2,149	53.72 3.40E 2	0.11
Eriogonum umbellatum	1,985	49.63 3.17E 2	0.10
Penstemon Newberryi	1,595	39.88 2.55E 2	0.08
Apocynum pumilum	1,361	34.02 2.18E 2	0.07
Chrysopsis Breweri	1,268	31.70 2.02E 2	0.06
Lupinus latifolius	1,098	27.45 1.70E 2	0.05
Lotus oblongifolius	1,020	25.50 1.62E 2	0.05
Hackelia mundula	649	16.23 1.04E 2	0.03
Monardella odorotissima	527	13.14 7.25E 1	0.02
Lupinus Breweri	413	10.32 6.57E 1	0.02

Comandra pallida	254	6.35 4.02E 1	0.01
Senecio aronicoides	247	6.17 3.95E 1	0.01
Lotus nevadensis	138	3.45 2.18E 1	0.01
Spiraea densiflora	112	2.80 1.78E 1	0.01
Veratrum californicus	100	2.50 1.58E 1	0.01
Smilacina racemosa	97	2.42 1.54E 1	T
Cynoglossum occidentale	90	2.25 1.42E 1	T
Dodecatheon Jeffreyi	88	2.20 1.40E 1	T
Pyrola picta	85	2.13 1.36E 1	T
Phacelia mutabilis	81	2.02 1.29E 1	T
Solanum Xantii	81	2.02 1.28E 1	T
Anaphalis margaritacea	68	1.70 1.08E 1	T
Hieracium spp.	61	1.52 9.66E 0	T
Taraxacum officinale	57	1.42 9.01E 0	T
Sphenosciadium capitellatum	50	1.25 7.91E 0	T
Calystegia malacophylla	46	1.15 7.27E 0	T
Castilleja disticha	36	0.90 5.69E 0	T
Lilium pardalinum	35	0.88 5.53E 0	T
Lomatium Nuttallii	35	0.88 5.53E 0	T
Ledum glandulosum	16	0.40 2.53E 0	T
Silene Lemmonii	2	0.05 3.16E-1	T